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Marketing Research Report No. 232

FLUID MILK PLANTS IN THE SOUTHEAST

Methods, Equipment, & Layout

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service
Marketing Research Division
in cooperation with
UNIVERSITY OF GEORGIA
College of Agriculture Experiment Stations

PREFACE

This research was conducted cooperatively by the Georgia Experiment Stations and the U. S. Department of Agriculture. Most of the data on work methods and equipment were obtained through studies of dairy plants in Georgia. The purpose of the research was to provide dairy plant operators with data and guidelines which can be used in establishing and operating milk plants more efficiently.

The work was conducted under the general supervision of George E. Turner, agricultural economist, Agricultural Marketing Service, and Harold D. White, agricultural engineer, College Experiment Station, University of Georgia.

Many dairy plant operators made their plants available for detailed studies of milk-handling operations. Dairy equipment companies provided current price data for dairy plant equipment.

Frederick C. Winter, associate professor of industrial engineering, Columbia University, and consultant to the Transportation and Facilities Branch, provided guidance and many valuable suggestions. Dr. Charles E. French, professor of agricultural economics, Purdue University, made valuable suggestions.

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SUMMARY

Labor and equipment requirements and costs were determined for methods used in performing fluid milk plant operations when the daily volume handled is 6,000 gallons. The methods are compared on the basis of these requirements and costs. They are grouped and compared for two types of plants. One receives milk in cans, bottles 40 percent in paper, 40 percent in glass, and packages 20 percent in dispenser cans (type 1). The other receives milk in bulk, bottles 80 percent in paper, and packages 20 percent in cans (type 2).

The application of improved work methods to can receiving operations reduces the cost from $2.90 to $2.68 per 1,000 gallons. When milk is received in bulk the cost is reduced from $1.36 to $1.21 per 1,000 gallons.

Processing milk is primarily a machine controlled cycle and the equipment costs account for approximately 62 percent of the total cost. A lack of balance in the equipment had little effect on processing costs, primarily because of high ownership cost associated with milk processing equipment.

The cost per 1,000 gallons for bottling 2,400 gallons in paper cartons and 2,400 gallons in glass bottles is $14.48 for a 6,000-gallon per day plant. The cost per 1,000 gallons for a plant bottling 4,800 gallons in paper only is $11.22. Costs are 23 percent less per 1,000 gallons for bottling in paper only and the reduction is due primarily to lower labor requirements.

The use of labor-saving equipment reduces the cost of packaging milk in dispenser cans by approximately 15 percent. The increased efficiency is effected by the use of such items of equipment as a power conveyor, a can washer, and a can filler valve.

The labor requirements for storing bottled and packaged milk are based primarily on the elapsed time of the bottling and packaging period. The total cost, however, is affected by the types of materials-handling equipment used. Storing costs are reduced when the 2-wheel case truck method is used, as opposed to the case dolly method.

Loading out costs also are reduced when the 2-wheel case truck method is used, as opposed to the case dolly method. The use of the 2-wheel case truck method, however, increases the time required for loading trucks by about 22 percent.

The methods employed for cleaning most items of milk-handling equipment are basically similar. However, if the equipment arrangement is well designed to provide a minimum footage of pipe, the cost for cleaning pipe in a 6,000-gallon per day plant is approximately 15 percent less for a take-down system than for a cleaned-in-place system.

Costs per 1,000 gallons are reduced for both types of plant by approximately 3.5 percent when the low cost combination of methods is used for handling milk. Cost per 1,000 gallons for handling milk in a type 2 plant with the low cost combination methods is about 16 percent less than that for a type 1 plant.

An increase in plant volume from 6,000 to 10,000 gallons per day in both types of plants reduces costs about 16 percent.

A layout is proposed for a 6,000-gallon per day fluid milk plant that receives milk in bulk, bottles in paper cartons and packages in dispenser cans. The layout shows a possible arrangement of equipment, and the flow of products, containers, and supplies through the plant. The layout of the suggested plant expanded to handle a daily volume of 10,000 gallons also is shown. An increase in plant volume of 67 percent requires an increase in plant area of less than 20 percent.

FLUID MILK PLANTS IN THE SOUTHEAST—METHODS, EQUIPMENT, AND LAYOUT

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INTRODUCTION

During the past 2 decades many innovations in fluid milk marketing have materially affected the work methods, equipment, and facility designs used in fluid milk plants. Among the major factors affecting plant operations have been: (1) A general development of more efficient types of equipment; (2) the advent of receiving milk in bulk; and (3) the trend to paper containers and dispenser cans.

This study was undertaken, therefore, to measure the effects of these innovations on the work methods and equipment used in fluid milk plants in Georgia. The objectives were to: (1) Measure the relative efficiencies of various work methods and various types and combinations of types of equipment used in fluid milk plants; (2) compare the various combinations of work methods and equipment types by plant types for the purpose of determining their effects on total plant costs; (3) appraise the effects of volume on labor and equipment requirements and costs; and (4) develop facility layouts, including equipment arrangement.

RESEARCH METHODS

Research was conducted in fluid milk plants in Georgia to cover all basic types of materials-handling, processing, and packaging equipment currently used, and all significant variables that affect the use of the equipment. The significant variables include: (1) The layout and design of the facility, (2) the equipment arrangement and the sequence of operations performed, (3) the type and size of containers used for receiving, bottling, packaging, and storing milk, and (4) the number of workers in a crew.

Time studies were made of the various work methods used to: (1) Determine the time required to perform the various operations, (2) determine the total man-hours of labor and total machine hours of equipment required, and (3) provide a basis for developing improved work methods and facility designs. From these time studies, labor and equipment costs for performing the various operations by the use of specified methods and types of equipment have been computed. A comparison of these costs shows the relative efficiencies obtained by performing operations with various methods and types of equipment and containers in Georgia milk plants.

There are also many types and combinations of types of products prepared. This study, however, has been limited to selected methods, types of equipment, and products in dairy plants handling only fluid milk, and is not intended to answer all problems or to cover all conditions existing in various dairy plants. Labor costs shown in these computations are based on the productive labor required for performing the operations. The equipment costs are based on the total machine-hours of use.

Management and facility costs have not been included in this study. The data, therefore, do not reflect total plant costs.

ASSUMED WAGE RATES

A wage rate of $1 per hour is assumed as the average for labor employed in Georgia dairy plants, and is used in computing labor costs. These costs are determined by multiplying the total productive labor by the assumed wage rate. Supervisory personnel are not included in the computations.

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[1] Mr. Brown transferred from the College Experiment Station to the Agricultural Marketing Service November 1956.

EQUIPMENT COSTS

Data on equipment costs were obtained from dairy equipment manufacturers, and are based on average f. o. b. prices for 1955 and 1956. The costs are grouped into two major categories, ownership costs and operating costs. The ownership costs include depreciation, interest, taxes, and insurance. These costs are considered to be fixed, and are computed on an annual basis. Interest rates are based on 5 percent of the average investment, and a combined figure for taxes and insurance is based on 2 percent of the initial investment. Operating costs are based on representative costs of electricity, water, fuel, and maintenance in Georgia dairy plants. The equipment costs used are a total of the ownership and operating costs.

DEFINITION OF TERMS

Base time is the time required for an operation performed at a normal pace by an operator skilled in the work.

Productive time is the time allowed for performing an operation. It is computed by adjusting base time for fatigue and personal allowance.

Unproductive time is time spent on the job which cannot be considered creative. It includes such items as unavoidable delay and idleness.

Personal allowance is the time allowed an operator to cover his personal needs, such as going to the lavatory, washing-up, drinking water, etc. In this report, a personal allowance of 5 percent will be added to the base time.

Fatigue allowance is the time allowed an operator to compensate for weariness induced by the work. The inherent fatigue is determined by the nature of the work, and the allowance added to the base time will vary from 5 to 25 percent.

Elapsed time is the total time consumed by an operation from beginning to end, including productive time, plus any necessary nonproductive time.

Milk can will, in this report, designate any 10-gallon can used for hauling milk from the farm to the plant.

Dispenser can will designate a 5-gallon can used as a container for milk dispensing machines.

Cases are box-like containers used for transporting bottles or cartons of milk. They are either wooden with steel bottoms or of wire construction. Bottle cases have wire inserts which separate the glass bottles. Bottle cases discussed in this report have 3 capacities—12 quarts, 20 pints, and 24 half pints. Carton cases will be standard in size, and will accommodate 20 quarts, 40 pints, or 50 half-pints.

FLUID MILK PLANT OPERATIONS

Inherent characteristics that affect efficiency in milk plant operations are: Variations in volume of milk handled from day to day, and also holiday and seasonal variations. Plants receive milk 7 days a week, and in many instances have little control over the time the milk arrives. Cans and tank trucks of milk arriving at the plant are not always filled to capacity. Milk is processed, bottled, and loaded out 6 days a week. In the handling of milk products there is an in-plant loss; a 2-percent loss is recognized as not being unreasonable. Practically all plants carry an operating reserve of milk, and an excess of butterfat or skim milk is common for most plants.

For the purposes of this study, it is assumed that: (1) Milk is received and processed at the rate of 6,000 gallons per day, 6 days per week; (2) cans and tank trucks arriving at the plant are filled to capacity; (3) the products processed utilize the receipts, and there is no shortage or excess of butter-fat or skim milk; (4) no in-plant losses of milk occur; and (5) no operating reserve of milk is carried.

Fluid milk plant operations are divided into 7 major operating cycles for the purpose of analyzing labor and equipment requirements. These cycles are: (1) Receiving milk, (2) processing milk, (3) bottling milk, (4) packaging milk in cans, (5) storing bottled and packaged milk, (6) loading out milk, and (7) cleaning milk-handling equipment. The operations within each cycle are analyzed according to the equipment and methods used. The total labor and equipment requirements are computed for each operation on a 1,000-gallon basis, the common unit in the Southeast.

The labor requirements shown do not account for waste time that results from improperly scheduled operations and oversized work crews. Furthermore, the time values established for specific operations should not be considered as standard, but as time values for the purpose of measuring the relative efficiencies of the various operations.

EQUIPMENT AND METHODS FOR RECEIVING MILK

Receiving milk involves moving milk into the plant, determining the quantity and butterfat content of the milk if these characteristics are not known, and storing the milk for subsequent preparation of milk products.

The majority of the dairy plants in Georgia receive milk in 10-gallon cans, but some plants are receiving milk from bulk truck tanks. A few dairies are in the process of converting from a can-receiving system to a bulk-receiving system, and are temporarily receiving milk by both mediums. The types of equipment and work methods for receiving milk in cans are different from those used for receiving milk in bulk; the work methods and equipment for receiving in cans and receiving in bulk, therefore, will be discussed separately and then compared on the basis of a daily receipt of 6,000 gallons.

EQUIPMENT USED FOR RECEIVING MILK

EQUIPMENT USED FOR RECEIVING MILK IN CANS

Many different types of equipment are used in receiving milk in cans in Georgia fluid milk plants. The principal types used are described below:

Conveyors—Milk cans are transported to and from the receiving room by conveyors which may be of two types, gravity or power (fig 1).

Gravity conveyors, which are designed specifically for milk cans, consists of a series of steel rollers. The power conveyor is equipped with a power-driven chain which drags the can along a track. The speed of the chain is synchronized with the operating capacity of the receiving equipment.

Dump bar—The dump bar (fig. 2) is the most common can-dumping device used in Georgia. It is a bar constructed of pipe at the end of the conveyor. The cans are pivoted over the bar as the milk is drained.

Cradle—The cradle (fig. 3), also known as the swinging dump bar, consists of a bottom plate and a semicircular bar which fits the contour of the can. When a can is placed in the cradle at the end of the conveyor, the assembly swings over and the milk drains into the tank.

Weigh tank—The weigh tank is a stainless steel tank supported from above by a scale. Most tanks incude an anti-splash strainer, and the more recent tanks are equipped with a dumping grid on which the can is placed while draining and then slid directly into the can washer. A large valve at the bottom of the tank allows the milk to drain into the receiving vat. Most valves are manually controlled.

Receiving vat—The receiving vat, which is also of stainless steel construction, is situated beneath the weigh tank, and the two tanks are connected by a conduit. The receiving vat serves as a reservoir for the milk before it is pumped to the cooler.

Scale—Scales used in receiving rooms are generally dial-type scales (fig. 4). Another type of scale is the automatic recording scale which is used by some dairies. This scale prints the weight of the milk on a ticket when the operator presses a button.

Can washer—Figures 5 and 6 illustrate a typical straight can washer. Straight can washers, range in capacity from 5 to about 16 cans per minute. The washer is equipped with an extended

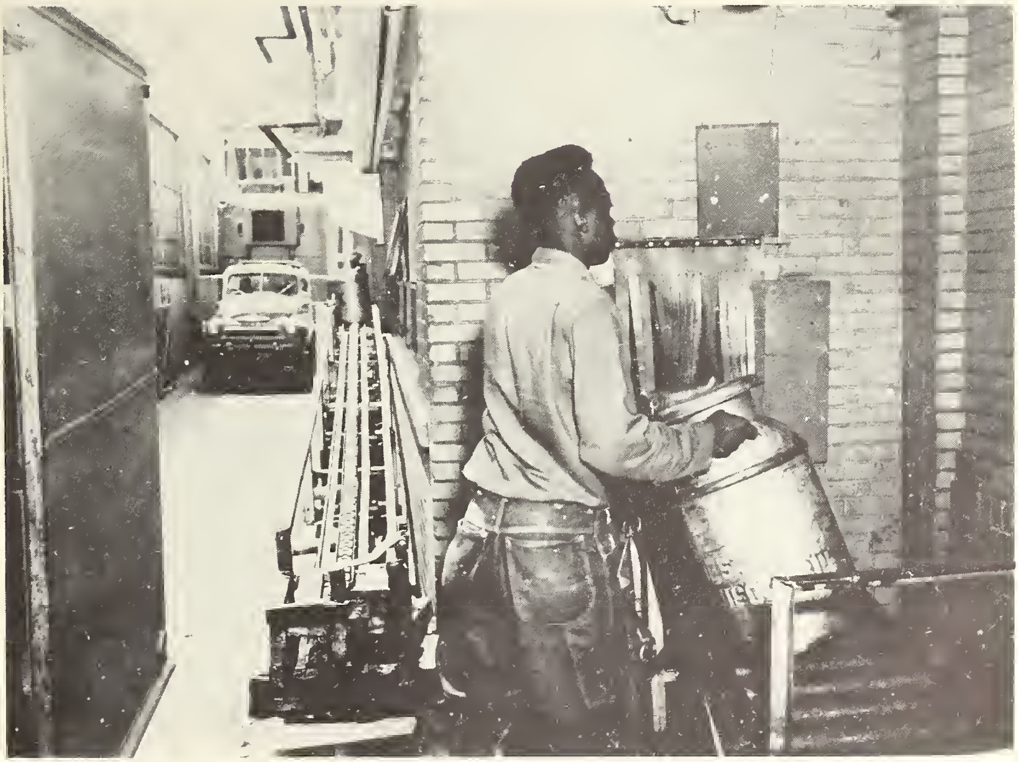
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Figure 1.—Can-receiving equipment with in-bound power conveyor on left, and out-bound gravity conveyor on right.

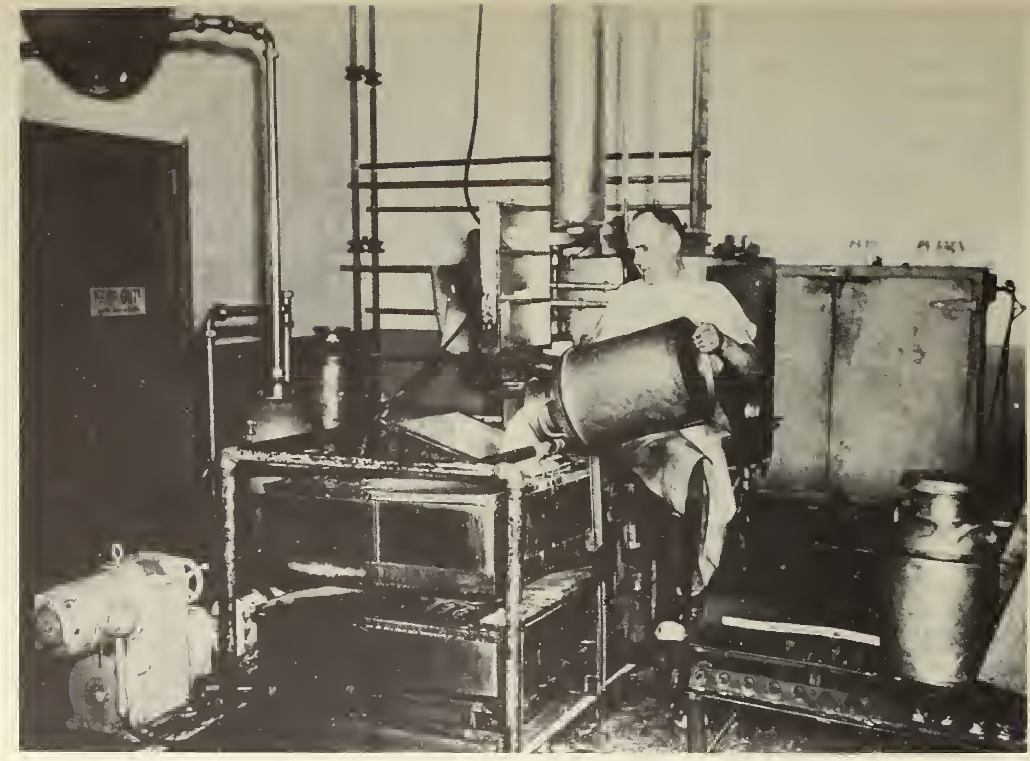

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Figure 2.—A worker dumps can of milk over a dump bar.

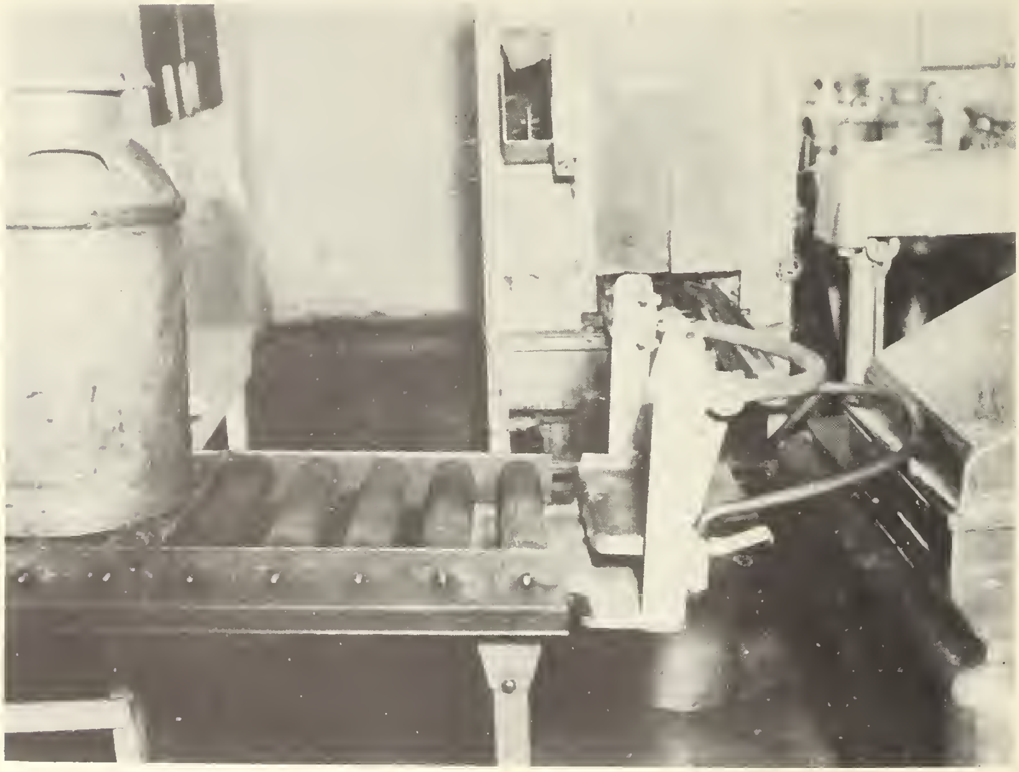

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Figure 3.—An incoming conveyor equipped with a cradle.

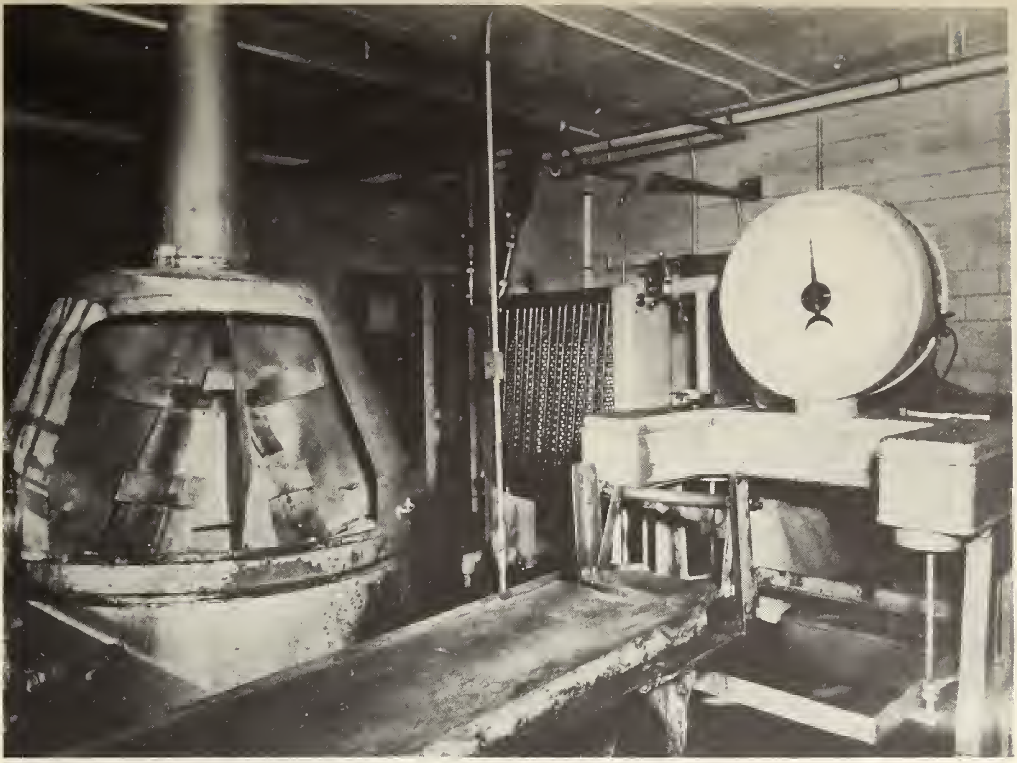

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Figure 4.—A typical receiving-room type of dial scale.

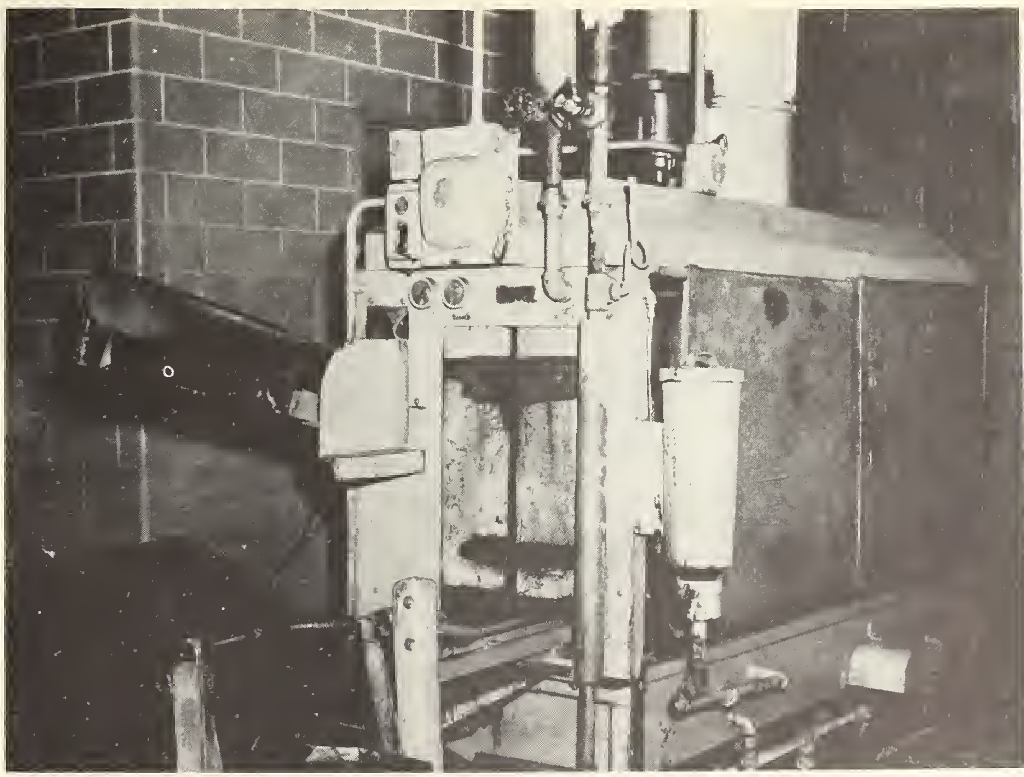

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Figure 5.—A milk can washer with a track extending to the weigh tank, and a rack for can covers.

track on which the inverted can is placed after dumping, and a can cover rack which conducts the cover through the washer.

Milk pump—Milk pumps used in receiving rooms are generally of the positive displacement type (fig. 7). The positive displacement pump does not agitate the milk, and it continues to operate when a vacuum occurs on the suction side.

Milk cooler—A milk cooler (fig. 8) is usually placed in the receiving room to refrigerate the milk. The milk is received at a temperature of about 50° F., and is cooled to about 40° F.

Piping—The piping in receiving rooms usually has an inside diameter of 1½ inches and in practically all cases is of stainless steel.

Storage tank—The incoming milk is stored at the plant in insulated storage tanks (fig. 9). The interior surface of the tank is stainless steel. One exterior face of the tank is usually stainless steel, and the remaining surfaces of the tank are usually painted metal. The stainless steel face has two glass ports at the top. A light bulb is attached to one port to illuminate the inside of the tank, and the other glass port is for observation. Also on that face are a manhole port for the operator, a port for the agitator, and at the top and bottom of the face respectively, are connections for the incoming and outgoing pipelines.

EQUIPMENT USED FOR RECEIVING MILK IN BULK

Equipment requirements for bulk receiving are less extensive than those for can receiving. The principal types of equipment used by Georgia dairy plants for receiving milk in bulk are described below.

Drain hose—A flexible plastic hose (fig. 10) is used to drain the incoming milk from the bulk truck tanks. The drain hose usually has a 2-inch I. D. (inside diameter), and is connected to the tank at one end and to the plant piping at the other end.

Pump—Pumps are sometimes used to remove milk from truck tanks. When pumps are employed, they are usually of the positive-displacement type which was described previously.

Piping—The piping which conducts the incoming milk to the storage tanks is 2-inch I. D. stainless steel piping.

Milk storage tank—Milk is piped to storage tanks from the truck tanks. The storage tanks used for bulk receiving are the same as those used for can receiving.

METHODS USED FOR RECEIVING MILK

METHODS USED FOR RECEIVING MILK IN CANS

Cans of milk are transported from the farm to the plant by either the individual producers or contract truckers, and are unloaded from the trucks to the receiving conveyor by the truck

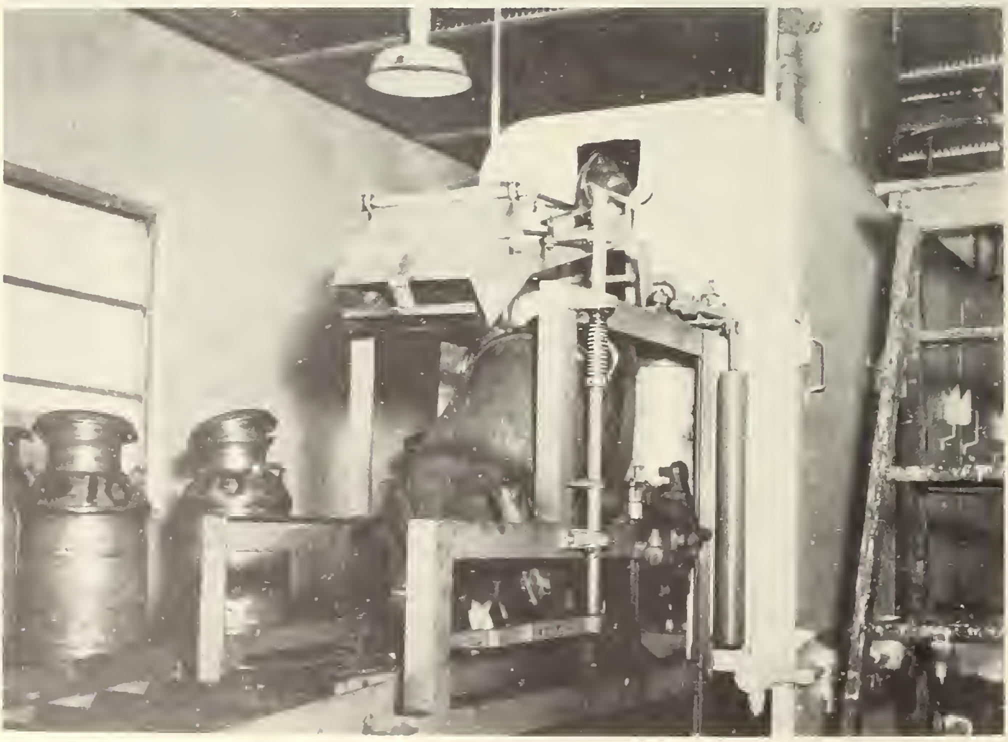

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Figure 6.—A can being turned upright as it leaves the washer. The washer is equipped with a lid replacing device.

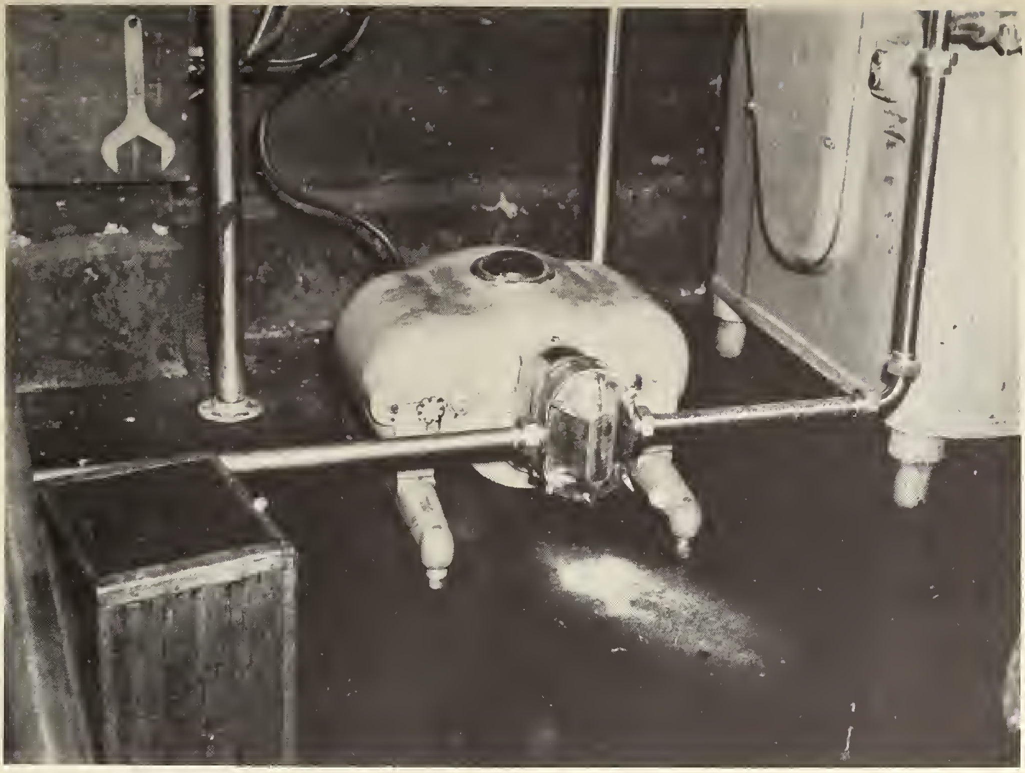

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Figure 7.—A positive-displacement type pump.

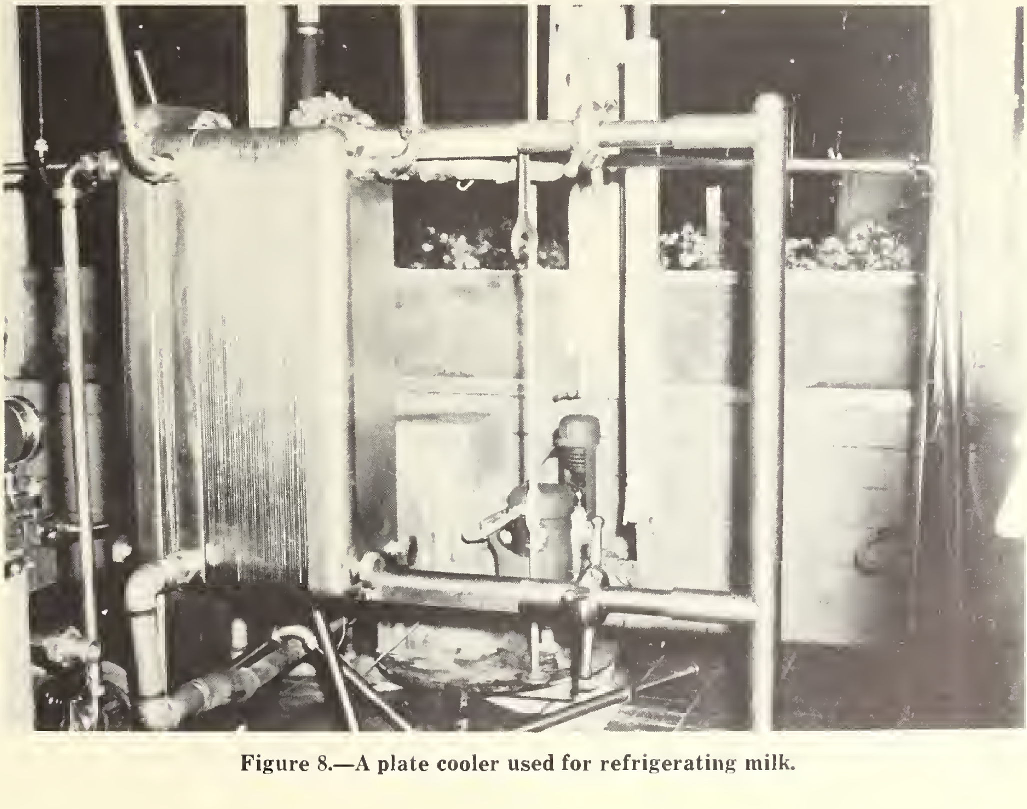

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Figure 8.—A plate cooler used for refrigerating milk.

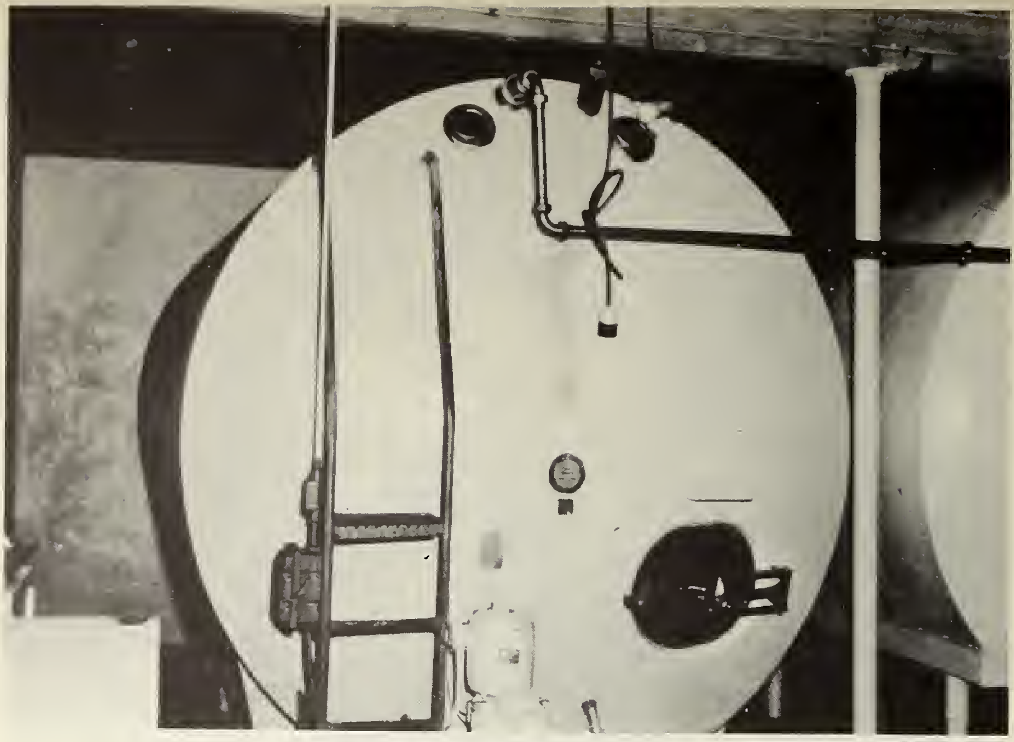

Figure 9.—A milk storage tank.

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Figure 10.—A bulk tank truck draining milk through a flexible plastic hose.

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drivers. On the basis of a schedule for truck arrivals, trucks begin arriving at the plant at 8 a. m., and milk is received continuously until all is received.

The can receiving methods and equipment used in Georgia are basically similar. However, there is considerable variation in the operational efficiencies realized by the use of different types and arrangements of equipment. Two methods of milk can receiving are discussed: (1) the gravity conveyor, dump bar, and dial scale method, and (2) the power conveyor, cradle dump, and recording scale method. The operations performed in receiving milk by both methods are: (1) Positioning cans, (2) dumping cans, (3) sampling milk, (4) weighing milk, (5) washing cans, and (6) cooling and storing milk. The work crew required for receiving 6,000 gallons of milk by both methods is one worker.

Receiving Milk in Cans by Gravity Conveyor, Dump Bar, and Dial Scale Method

Positioning cans for dumping milk includes conveying the cans from the unloading point to the receiving room, and pushing the cans to the dumping position. With the gravity conveyor, the worker manually pushes the cans along the conveyor for about 4 feet to the dumping device; the elapsed time required to position cans for dumping is 0.12 hour per 1,000 gallons of milk. The labor cost is 12 cents per 1,000 gallons.

The equipment cost based on a 25-foot gravity conveyor for 0.59 machine-hour is 2 cents per 1,000 gallons. The reason for the difference between the number of man hours of labor and the number of machine-hours of equipment used is that the equipment is in constant use throughout the entire operating cycle, whereas labor is required only for pushing the cans to the dumping device.

The total labor and equipment cost per 1,000 gallons for positioning cans with the gravity conveyor is 14 cents.

Dumping cans includes removing the lids and placing them in the washer, pouring the milk into the weigh tank, and pushing the inverted cans onto the washer track. Removing the lid and placing it in the lid rack of the washer is performed manually, and the time required is 0.07 hours per 1,000 gallons. During certain seasons milk must be graded for off-odors. Some milk may be rejected. However, rejections are infrequent, and no time is included for rejecting milk.

In dumping cans the receiving worker overturns the can on the bar and places it on the grid of the weigh tank while the milk drains into the tank. The efficiency with which cans are dumped with the dump bar depends upon the relative heights of the dump bar, the weigh tank, and the conveyor. A proper arrangement is one in which the conveyor is approximately 3 inches higher than the weigh tank, and the dump bar at the end of the conveyor is about 3 inches above the conveyor track. The can may then be rolled over the bar without being lifted. The elapsed time required for a worker to pour the milk with a dump bar, when using a proper arrangement of equipment, is 0.14 hour per 1,000 gallons. Many plants use a dump bar which is 12–15 inches above the conveyor track. Such an arrangement increases the pouring time by approximately 35 percent.

After the can is drained, the worker slides it along the grid to the washer track. He pushes the inverted can onto the washer track manually, and requires 0.05 hour per 1,000 gallons.

The total elapsed time for performing all 3 elements in dumping cans with the dump bar is 0.26 hour per 1,000 gallons of milk. The labor required, based on the elapsed time required, is 0.26 man-hour. The equipment requirement, based on a dump bar, is 0.14 machine-hour per 1,000 gallons. Because of the low cost of the dump bar (less than $0.001 per 1,000 gallons), no equipment cost is charged to the operation. The total cost for dumping cans with the dump bar, based only on the cost of labor, is 26 cents per 1,000 gallons.

Sampling milk—Producers are paid for their milk on the basis of quantity and butterfat content. Each producer's milk is sampled, therefore, as it is received into the plant. Samples are kept in half-pint bottles which are marked with the producers' numbers, and the bottles are kept in cases near the weigh tank. The sample case should be positioned as conveniently as possible for the operator during receiving operations, and should be kept under refrigeration at all other times.

Sampling milk includes picking up the sample bottle and dipper, opening the bottle, drawing a sample through a port in the top of the weigh tank, pouring the sample into the bottle, recovering and replacing the bottle, and rehanging the dipper. This method of sampling is used by almost all plants in Georgia. The labor requirements for sampling are determined on the basis of an average receipt of 5 cans or 50 gallons per producer. The elapsed time required to perform the operation is 0.06 hour per 1,000 gallons. The total cost for performing the operation, 6 cents per 1,000 gallons, is based on the labor cost alone. The equipment cost, based on the bottles and dipper, is too low to be considered in this study.

Weighing milk includes determining the weight of the milk, and recording the basic data such as weight, date, and producer number on a producer's receipt. Weight determinations are made when the weigh tank has been filled, or when the tank contains one producer's entire supply of milk. The basic data are recorded while the milk in the tank is draining into the receiving vat. When weighing is performed with the dial-type scale, the worker reads the weight on the face of the scale. He then releases the milk drain valve, and records the necessary information on the producer's receipt. The elapsed time for performing the operation by this method is 0.15 hour per 1,000 gallons. The elapsed time per 1,000 gallons is based on 0.02 hour to determine the weight, and 0.13 hour to record the data. The total labor required to perform the operation is 0.15 man-hour and the labor cost is 15 cents. The equipment cost, based on a 1,000-pound dial scale and a 500-pound weigh tank for 0.59 machine-hour each for a total 1.18 machine-hours, is 18 cents per 1,000 gallons. The total labor and equipment cost for performing the operation with the dial-type scale is 33 cents per 1,000 gallons. The reason for the difference in the number of man-hours and machine-hours required for the operation is that man-hours refer only to the time required to observe the weight and record the data; the dial scale and the weigh tank are in use throughout the entire operating cycle.

Washing cans and lids is a completely automatic operation. The inverted can is drawn into the washer, and the can and lid are subjected to cleaning treatments as they are conducted through the machine. The can is then turned upright, the lid is replaced, and the can is discharged from the washer and returned to the truck on a gravity conveyor.

The can washer for a typical 6,000-gallon plant washes cans at a rate of 5 to 7 per minute. No labor is involved. The cost of the operation is based upon the efficiency or the rate at which cans are received into the plant, since the machine runs continuously from beginning to end of the receiving period. When cans are received by the gravity conveyor, dump bar, and dial scale method, the elapsed time required per 1,000 gallons to receive milk is 0.59 hour. The total cost of washing cans, based on a 5- to 7-can-per-minute washer and a 55-foot outgoing conveyor for 0.59 machine-hour each, for a total of 1.18 machine-hours, is 85 cents per 1,000 gallons.

Cooling and storing milk begins when the milk from the weigh tank enters the receiving vat. The operation is machine controlled, and includes holding the milk in the receiving vat, pumping it through a plate cooler and to a milk storage tank, and storing the milk until it is removed for processing.

The efficiency with which the operation is performed is based upon the balance of the equipment, for instance, the capacity of the receiving vat should exceed that of the weigh tank. With a 500-pound weigh tank, a 1,000-pound receiving vat is usually used. The capacities of the pump and cooler should be based on the rate at which milk is received into the plant. When milk is received by the gravity conveyor, dump bar, and dial scale method, it is received at a rate of 14,600 pounds per hour (1,698 gallons per hour). A 19,000-pound-per-hour pump and a 15,000-pound-per-hour plate cooler, the closest available equipment sizes, are used. The capacities of the raw milk storage tanks are based upon both the receiving and the processing schedules. Two 4,000-gallon tanks are used to insure adequate storage capacity in the event of variations in the daily receiving or processing volume. It is assumed that the tanks are used 24 hours per day for the storage of milk.

The cost for cooling and storing milk, based on a 1,000-pound receiving vat, a 19,000-pound-per-hour-pump, a 15,000-pound-per-hour plate cooler, and 22 feet of piping plus fittings for 0.59 machine-hour each, and two 4,000-gallon milk storage tanks for 4.00 machine-hours each, for a total of 10.36 machine hours, is $1.26 per 1,000 gallons. The operation is automatic and no labor is involved.

A summary of requirements for receiving milk in cans by the gravity conveyor, dump bar, and dial scale method is shown in table 1.

TABLE 1.—*Summary of labor and equipment requirements and costs per 1,000 gallons for receiving 6,000 gallons of milk in cans by the gravity conveyor, dump bar, and dial scale method, by operations, with a one-man crew*

Operation	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Positioning cans	0. 12	[1] 0. 59	0. 12	0. 02	0. 14
Dumping cans	. 26	[2] . 14	. 26	(3)	. 26
Sampling milk	. 06	(4)	. 06	(3)	. 06
Weighing milk	. 15	[5] 1. 18	. 15	. 18	. 33
Washing cans	(6)	[7] 1. 18	(6)	. 85	. 85
Cooling and storing milk	(6)	[8] 10. 36	(6)	1. 26	1. 26
Total	. 59	13. 45	. 59	2. 31	2. 90

[1] 25-foot gravity conveyor for 0.59 machine-hour.

[2] Dump bar for 0.14 machine-hour.

[3] The cost of the equipment is too low to be included in this analysis.

[4] No machine time charged to operation.

[5] 1,000-pound dial scale for 0.59 machine-hour, and a 500-pound weigh tank for 0.59 machine-hour.

[6] Operation automatic—no labor required.

[7] 5- to 7-can-per-minute washer for 0.59 machine-hour and a 55-foot outgoing gravity conveyor for 0.59 machine-hour.

[8] 1,000-pound receiving vat for 0.59 machine-hour, a 19,000-pound-per-hour pump for 0.59 machine-hour, a 15,000-pound-per-hour plate cooler for 0.59 machine-hour, 22 feet of pipe, plus fitting, for 0.59 machine-hour and two 4,000-gallon raw milk storage tanks for 4.00 machine-hours each.

Receiving Milk in Cans by the Power Conveyor, Cradle Dump, and Recording Scale Method

Positioning cans includes transporting the cans from the unloading point to the dumping position in the receiving room. Most power conveyors are equipped with foot- or knee-operated can stops which feed one can at a time to the operator, and prevent a piling-up of cans at the dumping position. Positioning cans with a power conveyor does not involve any labor on the part of the worker. The power conveyor operates continuously and the total elapsed time for performing the operation is 0.36 hour. The total cost based on a 25-foot power conveyor for 0.36 machine-hour is 10 cents per 1,000 gallons.

Dumping cans includes removing the lids and placing them in the washer, pouring the milk into the weigh tank, and pushing the inverted cans onto the washer track. Removing the lid and placing it on the washer track is performed manually, and the elapsed time required is 0.07 hour per 1,000 gallons.

When the cradle dump is employed in dumping cans, the prepositioned can is turned over with the cradle and placed on the grid, and the milk is poured into the weigh tank. The base of the cradle should be on a higher level than the top of the tank so that the full can, which weighs approximately 110 pounds, may be pushed over instead of being lifted. The elapsed time for pouring the milk with a cradle is 0.10 hour per 1,000 gallons. After the can is drained it is slid along the grid to the washer track. Pushing the inverted can onto the washer track is performed manually and the elapsed time required is 0.05 hour per 1,000 gallons. The total elapsed time required for dumping cans with a cradle dump is 0.22 hour. The labor requirements are 0.22 man-hour.

Because of the low cost of the cradle dump ($0.003 per 1,000 gallons) no equipment cost is charged to the operation. The total cost for dumping cans with the cradle dump based only on a labor cost is 22 cents per 1,000 gallons.

Sampling milk—The methods, equipment, and cost of sampling milk are the same as those previously described under sampling milk with the gravity conveyor, dump bar, and dial scale method of receiving milk in cans. The elapsed time required to perform the operation is 0.06 hour per 1,000 gallons. The total labor required is 0.06 man-hour. The total cost, based on the cost of labor alone, is 6 cents per 1,000 gallons.

Weighing milk—The elements of the weighing operation are the same as those described for weighing in receiving milk in cans by the gravity conveyor, dump bar, and dial scale method.

When the weighing operation is performed with the recording scale, the weight of the milk is stamped on the producer's receipt which has been placed in a slot in the scale. The worker presses a button to record the weight, removes the receipt, manually records the date and producer number, and then places a new receipt in the scale slot. The elapsed time for performing the operation is 0.08 hour per 1,000 gallons. The elapsed time per 1,000 gallons is based on 0.01 hour to push the button, and 0.07 hour to record the remaining data and replace the receipt.

The labor required for performing the operation is 0.08 man-hour or 8 cents per 1,000 gallons. The equipment cost based on a 1,000-pound recording scale for 0.36 machine-hour, and a 500-pound weigh tank for 0.36 machine-hour for a total of 0.72 machine-hour, is 21 cents per 1,000 gallons. The total labor and equipment cost for performing the operation is 29 cents per 1,000 gallons.

Washing cans—The methods and equipment for washing cans are the same as those previously described under washing cans with the gravity conveyor, dump bar, and dial scale method of receiving milk in cans.

The cost of the operation is based upon the efficiency or the rate at which cans are received into the plant, since the machine runs continuously from the beginning to the end of the receiving period. When cans are received by the power conveyor, cradle dump, and recording scale methods, the elapsed time required per 1,000 gallons for receiving milk is 0.36 hour. The total cost of the operation based on a 5- to 7-can per-minute washer and a 55-foot outgoing conveyor for 0.36 machine-hour each, for a total of 0.72 machine-hour, is 69 cents per 1,000 gallons. No labor is involved in performing the operation.

Cooling and storing milk was described under cooling and storing milk by the gravity conveyor, dump bar, and dial scale method of receiving milk in cans.

The efficiency with which the operation is performed is based upon the balance of equipment. The capacities of the pump and cooler should be based on the rate at which milk is received into the plant. When milk is received with the power conveyor it is received at the rate of 23,900 pounds per hour (2,779 gallons per hour). A 25,000-pound-per-hour pump and a 25,000-pound-per-hour plate cooler are used. The capacities of the raw milk storage tanks are based on the receiving and processing schedule; consequently, two 4,000-gallon tanks are used. It is assumed that the tanks are used 24 hours per day for the storage of milk.

The cost of cooling and storing milk, based on a 1,000-pound receiving vat, a 25,000-pound-per-hour pump, a 25,000-pound-per-hour plate cooler and 22 feet of piping, plus fittings, for 0.36 machine-hour each, and two 4,000-gallon milk storage tanks for 4.00 machine-hours each, for a total of 9.44 machine-hours, is $1.32 per 1,000 gallons. The operation is automatic and no labor is involved.

A summary of requirements for receiving milk in cans by the power conveyor, cradle

Table 2.—*Summary of labor and equipment requirements and costs per 1,000 gallons for receiving 6,000 gallons of milk in cans by the power conveyor, cradle dump, and recording scale method, by operations, with a one-man crew*

Operation	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Positioning cans	(1)	[2] 0.36	(1)	0.10	0.10
Dumping cans	0.22	[3] .10	.22	(4)	.22
Sampling milk	.06	(5)	.06	(4)	.06
Weighing milk	.08	[6] .72	.08	.21	.29
Washing cans	(1)	[7] .72	(1)	.69	.69
Cooling and storing milk	(1)	[8] 9.44	(1)	1.32	1.32
Total	.36	11.34	.36	2.32	2.68

[1] Operation automatic—no labor required.

[2] 25-foot power conveyor for 0.36 machine-hour.

[3] A cradle dump for 0.10 machine-hour.

[4] The cost of the equipment is too low to be included in this analysis.

[5] No machine time charged to operation.

[6] A 1,000-pound recording scale and a 500-pound weigh tank for 0.36 machine-hour each.

[7] A 5- to 7-can-per-minute washer for 0.36 machine-hour and a 55-foot outgoing gravity conveyor for 0.36 machine-hour.

[8] A 1,000-pound receiving vat for 0.36 machine-hour, a 25,000-pound-per-hour positive displacement pump for 0.36 machine-hour, a 25,000-pound-per-hour plate cooler for 0.36 machine-hour, and 22 feet of piping, plus fittings, for 0.36 machine-hour, and two 4,000-gallon milk storage tanks for 4.00 machine-hours each.

dump, and recording scale method is given in table 2.

COMPARISON OF THE TWO METHODS OF RECEIVING MILK IN CANS

The total labor and equipment cost for receiving milk in cans by the gravity conveyor, dump bar and dial scale method is $2.90 per 1,000 gallons as compared with $2.68 with the power conveyor, cradle dump, and recording scale method (table 3). The reduction in labor and equipment cost is 22 cents per 1,000 gallons in receiving cans of milk with the power conveyor, cradle dump, and recording scale method. Almost all of the reduction in costs is in the cost of labor—the equipment cost is practically the same for both methods.

The power conveyor, cradle dump, and recording scale method, in addition to being the lowest-cost method for receiving milk in cans, permits milk in cans to be received at a faster rate. The total elapsed time required for receiving 1,000 gallons of milk by this method is 0.36 hour as compared with an elapsed time of 0.59 hour when milk in cans is received by the gravity conveyor, dump bar, and dial scale method.

Table 3.—*Labor and equipment requirements and costs per 1,000 gallons for receiving 6,000 gallons of milk in cans by the gravity conveyor, dump bar, and dial scale method, and by the power conveyor, cradle dump, and recording scale method, with a one-man crew*

Method	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Gravity conveyor, dump bar, and dial scale method	0.59	[1] 13.45	0.59	2.31	2.90
Power conveyor, cradle dump, and recording scale method	.36	[2] 11.34	.36	2.32	2.68

[1] A 25-foot gravity conveyor for 0.59 machine-hour a dump bar for 0.14 machine hour, a 1,000-pound dial scale for 0.59 machine-hour, a 500-pound weigh tank for 0.59 machine-hour, a 5-7 can-per-minute can washer for 0.59 machine hour, a 55-foot outgoing gravity conveyor for 0.59 machine-hour, a 1,000-pound receiving vat for 0.59 machine-hour, a 19,000-pound-per-hour positive-displacement pump for 0.59 machine-hour, a 15,000-pound-per-hour plate cooler for 0.59 machine-hour, 22 feet of piping, plus fittings, for 0.59 machine-hour, and two 4,000-gallon milk storage tanks for 4.00 machine-hours each.

[2] A 25-foot power conveyor for 0.36 machine-hour, a cradle dump for 0.10 machine-hour, a 1,000-pound recording scale for 0.36 machine-hour, a 500-pound weigh tank for 0.36 machine-hour, a 5- to 7-can-per-minute can washer for 0.36 machine-hour, a 55-foot outgoing gravity conveyor for 0.36 machine-hour, a 1,000-pound receiving vat for 0.36 machine-hour, a 25,000-pound-per-hour positive-displacement pump for 0.36 machine-hour, a 25,000-pound-per-hour plate cooler for 0.36 machine-hour, 22 feet of piping, plus fittings, for 0.36 machine-hour, and two 4,000-gallon milk storage tanks for 4.00 machine-hours each.

METHODS USED FOR RECEIVING MILK IN BULK

Bulk milk is picked up at the farm and delivered to the plant by contract truckers. The butterfat sample is taken and the volume determined at the farm by the truck driver, so there are no sampling or weighing operations performed at the plant when milk is received. On the basis of a plant receiving 6,000 gallons per day, it is assumed that the milk is delivered by four 1,500-gallon tank-trucks, each with a full tank. The trucks would be scheduled to insure a continuous flow of milk into the plant. Space would be available in a shelter area for two trucks, although only one truck would be drained at a time.

The bulk receiving operations are discussed on the basis of two methods, the gravity-drain method and the pump-drain method. The operations performed in receiving milk by the two methods are: (1) Positioning truck in shelter area and checking milk; (2) transferring milk from truck tank to storage tank; (3) cleaning truck tank; and (4) removing truck from shelter area. The receiving crew for each method consists of one worker. Upon completion of the receiving operations the worker is assigned other duties.

Receiving Milk in Bulk by the Gravity-Drain Method

Positioning truck and checking milk includes positioning the truck in the shelter area, climbing on the truck, opening the port cover, checking the odor and appearance of the milk, and climbing down. Although the truck-driver positions the truck, he is guided by the plant worker who then performs the other duties. The time for performing this operation on a per truck basis is 2.40 minutes. However, it is assumed that milk received in bulk would be received into the plant continuously. Therefore the time required for positioning truck and checking milk is based only on the time required for the first truck because the operation for all subsequent trucks is performed while the previous truck is draining. The elasped time required per 1,000 gallons for positioning and checking the truck is 0.01 hour. The labor required per 1,000 gallons is 0.01 man-hour and the labor cost is 1 cent. No equipment is used in performing the operation.

Transferring milk from the truck tanks to storage tanks by gravity-drain includes connecting a drain hose to the outlet of the truck tank, opening the tank drain valve, permitting the tank to drain, and disconnecting the hose from the truck tank outlet. The elapsed time for connecting and disconnecting the hose is 0.01 hour per 1,000 gallons. When the milk is transferred from the truck tank to the storage tank by gravity drain, the elapsed time required per 1,000 gallons is 0.46 hour. The total elapsed time required for performing the operation is 0.47 hour. The labor required is 0.47 man-hour per 1,000 gallons and the total labor cost, 47 cents. The equipment cost, based on a 15-foot drain hose for 0.46 machine-hour, 20 feet of piping for 0.46 machine-hour, and two 4,000 gallon storage tanks for 4.00 machine-hours each, for a total of 8.92 machine-hours, is 85 cents per 1,000 gallons. The total labor and equipment cost for transferring milk from tank trucks to storage tanks by gravity drain is $1.32 per 1,000 gallons.

Cleaning truck tank—After the milk has been drained from the truck tank, the inside of the tank is cleaned by the worker. The operation includes dismantling and cleaning the drain valve, climbing in the tank, dismantling and cleaning the manhole cover, prerinsing the interior of the tank and scrubbing it with a cleaning solution, rinsing all washed surfaces, reassembling all parts, and climbing down. The total elapsed time required to clean a 1,500-gallon tank is 0.18 hour. With the exception of the last truck tank, the operation is performed while another truck tank is draining. The labor required for cleaning the last truck tank is 0.03 man-hour per 1,000 gallons, based on receiving 6,000 gallons. The labor cost is 3 cents. No equipment cost is involved.

Removing trucks from shelter area involves driving the empty truck out of the shelter after it has been washed. The truck is removed by the driver, but the receiving worker is delayed while the operation is being performed. The total elapsed time required to remove the truck from the shelter areas is based only on the time required for removing the last truck. The labor required for the operation is 0.0001 man-hour per 1,000 gallons of milk.

A summary of requirements for receiving milk in bulk by the gravity-drain method is given in table 4.

TABLE 4.—*Summary of labor and equipment requirements per 1,000 gallons for receiving 6,000 gallons of milk in bulk by the gravity-drain method, by operations, with a one-man crew*

Operation	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Positioning truck in shelter area and checking milk	0.01	(1)	0.01	(1)	0.01
Transferring milk from truck tank to storage tank	.47	[2] 8.92	.47	0.85	1.32
Cleaning truck tank	.03	(1)	.03	(1)	.03
Removing truck from shelter area	(3)	(1)	(3)	(1)	------
Total	.51	8.92	.51	.85	1.36

[1] No equipment required.

[2] A 15-foot drain hose for 0.46 machine-hour, 20 feet of piping, plus fittings, for 0.46 machine-hour, and two 4,000-gallon storage tanks for 4.00 machine-hours each.

[3] Labor requirements 0.001 man-hour.

Receiving Milk in Bulk by the Pump-Drain Method

Positioning truck in shelter area and checking milk is the same as described for the gravity-drain method. The labor requirements and costs also are the same—0.01 man-hour and 1 cent per 1,000 gallons. No equipment costs are involved.

Transferring milk from the truck tanks to storage tanks by the pump-drain method includes connecting a drain hose to the outlet of the truck tank, opening truck tank drain valve, starting the pump, permitting the tank to drain, stopping the pump, and disconnecting the hose. The elapsed time for connecting and disconnecting the hose and starting and stopping the pump is 0.01 hour. Milk is transferred from the truck tank to the storage tank by pump-drain at a rate of 51,600 pounds per hour, and the elapsed time required per 1,000 gallons is 0.17 hour. The total elapsed time required for performing the operation is 0.18 hour. The labor required is 0.18 man-hour per 1,000 gallons and the total labor cost is 18 cents. The equipment cost, based on a 15-foot drain hose for 0.17 machine-hour, 20 feet of piping for 0.17 machine-hour, a 60,000-pound-per-hour positive-displacement pump for 0.17 machine-hour, and two 4,000-gallon storage tanks for 4.00 machine-hours each, for a total of 8.51 machine-hours, is 99 cents per 1,000 gallons. The total labor and equipment cost for transferring milk from truck tanks to storage tanks by the pump-drain method is $1.17 per 1,000 gallons.

The cleaning truck tank operation is the same as that described for cleaning truck tanks by the gravity-drain method. The labor requirements and costs, 0.03 man-hour and 3 cents per 1,000 gallons, also are the same. No equipment is involved.

The removing truck from shelter area is the same as that described for removing trucks by the gravity-drain method. The labor requirements also are the same—0.001 man-hour per 1,000 gallons. No equipment is involved.

A summary of requirements for receiving milk in bulk by the pump-drain method is shown in table 5.

Table 5.—*Summary of labor and equipment requirements per 1,000 gallons for receiving 6,000 gallons of milk in bulk by the pump-drain method, by operations, with a one-man crew*

Operation	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Positioning truck in shelter area and checking milk	0.01	(1)	0.01	(1)	0.01
Transferring milk from truck tank to storage tank	.18	[2] 8.51	.18	0.99	1.17
Cleaning truck tank	.03	(1)	.03	(1)	.03
Removing truck from shelter area	(3)	(1)	(3)	(1)	-----
Total	.22	8.51	.22	0.99	1.21

[1] No equipment required.

[2] A 15-foot drain hose for 0.17 machine-hour, 20 feet of piping, plus fittings, for 0.17 machine-hour, a 60,000-pound per- hour positive-displacement pump for 0.17 machine-hour, and two 4,000-gallon storage tanks for 4.00 machine-hours each.

[3] Labor requirements 0.001 man-hour.

COMPARISON OF TWO METHODS OF RECEIVING MILK IN BULK

The labor and equipment costs for receiving milk in bulk by the gravity-drain method is $1.36 per 1,000 gallons as compared with $1.21 per 1,000 gallons when milk in bulk is received by the pump-drain method. The pump-drain method is the lowest cost method for receiving milk in bulk and results in a reduction of 15 cents per 1,000 gallons.

The labor and equipment costs for positioning truck in shelter area and checking milk, cleaning truck tank, and removing truck from shelter area are the same for both methods. However, lower labor costs are incurred when milk is transferred from truck tanks to storage tanks by the pump-drain method than by the gravity-drain method. All of the reduction in the cost for transferring milk with the pump-drain method is based on the cost of labor. Labor cost is reduced 29 cents per 1,000 gallons. The equipment cost, however, is increased 14 cents per 1,000 gallons because of the increased equipment requirements. Table 6 shows the total cost for receiving milk in bulk by the two methods.

Table 6.—*Comparison of labor and equipment requirements and cost per 1,000 gallons for receiving 6,000 gallons of milk in bulk by the gravity-drain method and by the pump-drain method, with a one-man crew*

Method	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Gravity-drain method	0.51	[1] 8.92	0.51	0.85	1.36
Pump-drain method	.22	[2] 8.51	.22	.99	1.21

[1] A 15-foot drain hose for 0.46 machine-hour, 20 feet of piping, plus fittings, for 0.46 machine-hour, and two 4,000-gallon storage tanks for 4.00 machine-hours each.

[2] A 15-foot drain hose for 0.17 machine-hour, 20 feet of piping, plus fittings, for 0.17 machine-hour, a 60,000-pound-per-hour positive-displacement pump for 0.17 machine-hour, and two 4,000-gallon storage tanks for 4.00 machine-hours each.

COMPARISON OF METHODS FOR RECEIVING MILK IN CANS AND IN BULK

The labor and equipment cost for receiving milk in cans by the gravity conveyor, dump bar, and dial scale method is $2.90 per 1,000 gallons (table 7). This cost is compared with a cost of $2.68 per 1,000 gallons for receiving milk in cans by the power conveyor, cradle dump, and recording scale method. The power conveyor, cradle dump, and recording scale method is the lowest cost method for receiving milk in cans and costs are reduced 22 cents per 1,000 gallons when it is used.

The labor and equipment cost for receiving milk in bulk by the gravity-drain method is $1.36 per 1,000 gallons as compared to a cost of $1.21 when the pump-drain method is used. The pump-drain method is the lowest cost method for receiving milk in bulk and results in a reduction of 15 cents per 1,000 gallons.

Regardless of the methods used, the cost of receiving milk in bulk is less than the cost of receiving milk in cans. The lowest cost method for receiving milk in cans is the power conveyor, cradle dump and recording scale method. The cost per 1,000 gallons for receiving milk in cans by this method is $2.68 as compared with $1.21 for receiving milk in bulk by the pump-drain method. Thus, the costs for receiving milk in bulk by the lowest cost method is $1.47 per 1,000 gallons less than the lowest cost method for receiving milk in cans. The difference in the costs for receiving milk in bulk and in cans is largely in the equipment cost, although some reduction in labor costs are incurred. The equipment costs per 1,000 gallons of receiving milk in bulk is only about a third of the equipment cost for receiving milk in cans.

Table 7.—*Comparison of labor and equipment requirements and costs per 1,000 gallons for receiving milk in cans and in bulk, with a one-man crew, by methods*

Method	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
Receiving milk in cans:					
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Gravity conveyor, dump bar, and dial scale method	0.59	[1] 13.45	0.59	2.31	2.90
Power conveyor, cradle dump, and recording scale method	.36	[2] 11.34	.36	2.32	2.68
Receiving milk in bulk:					
Gravity-drain method	.51	[3] 8.92	.51	.85	1.36
Pump-drain method	.22	[4] 8.51	.22	.99	1.21

[1] A 25-foot gravity conveyor for 0.59 machine-hour, a dump bar for 0.14 machine-hour, a 1,000-pound dial scale for 0.59 machine-hour, a 500-pound weigh tank for 0.59 machine-hour, a 5- to 7-can-per-minute washer for 0.59 machine-hour, a 55-foot outgoing gravity conveyor for 0.59 machine-hour, a 1,000-pound receiving vat for 0.59 machine-hour, a 19,000-pound-per-hour positive-displacement pump for 0.59 machine-hour, a 15,000-pound-per-hour plate cooler for 0.59 machine-hour, 22 feet of piping, plus fittings, for 0.59 machine-hour, and two 4,000-gallon milk storage tanks for 4.00 machine-hours each.

[2] A 25-foot power conveyor for 0.36 machine-hour, a cradle dump for 0.10 machine-hour, a 1,000-pound recording scale for 0.36 machine-hour, a 500-pound weigh tank for 0.36 machine-hour, a 5- to 7-can-per-minute can washer for 0.36 machine-hour, a 55-foot outgoing gravity conveyor for 0.36 machine-hour, a 1,000-pound receiving vat for 0.36 machine-hour, a 25,000-pound-per-hour positive-displacement pump for 0.36 machine-hour, a 25,000-pound-per-hour plate cooler for 0.36 machine-hour, 22 feet of piping, plus fittings, for 0.36 machine hour, and two 4,000-gallon milk storage tanks for 4.00 machine-hours each.

[3] A 15-foot drain hose for 0.46 machine-hour, 20 feet of piping, plus fittings, for 0.46 machine-hour, and two 4,000-gallon storage tanks for 4.00 machine-hours each.

[4] A 15-foot drain hose for 0.17 machine-hour, 20 feet of piping, plus fittings, for 0.17 machine-hour, a 60,000-pound-per-hour positive-displacement pump for 0.17 machine-hour, and two 4,000-gallon storage tanks for 4.00 machine-hours each.

EQUIPMENT AND METHODS FOR PROCESSING MILK

Milk processing includes those operations in which milk is transformed into the several products. The products are usually prepared in one room which is situated between the receiving and bottling areas. Although at one time the processing of milk entailed a considerable amount of labor, in present-day plants it is mostly machine controlled and operated. The equipment and methods required for conducting the processing operations are dependent upon the types and quantities of products prepared. The combinations of products prepared vary widely among fluid milk plants. For the purpose of analyzing the equipment and work methods employed in processing milk at a 6,000-gallon-per-day plant, however, the following distribution of products is used: 4,560 gallons of homogenized milk, 300 gallons of regular milk, 420 gallons of chocolate drink, 60 gallons of skim milk, 60 gallons of cream, and 600 gallons of buttermilk.

The processing rate of a fluid milk plant should be based upon the bottling rates, and the bottling rates are dependent upon the types of bottling machines employed, and the type, size, and quantity of containers filled. On the basis of the types of bottling machines and type, size, and quantity of containers assumed for the purposes of this report, the processing rate which provides the most effcient utilization of labor and equipment is 7,000 pounds per hour (814 gallons per hour).

EQUIPMENT USED FOR PROCESSING MILK

Milk pumps—Two types of milk pumps are used in processing rooms, positive-displacement pumps and centrifugal pumps. Positive-displacement pumps are used when it is necessary to supply machines with a constant volume of milk, and with a minimum turbulence. Centrifugal pumps are used to pump milk from one tank to another when the rate of flow is of secondary importance.

Standardizing clarifier—The standardizing clarifier (fig. 11) performs two operations simultaneously. Standardization is the process of regulating the butterfat content of the milk, and clarification is the removal of sediment from the milk by centrifugal action. Milk is pumped into the bottom of the machine by a positive-displacement pump, and standardized milk and excess cream are forced out through separate outlets at the top.

Separator—The separator (fig. 12) separates whole milk into skim milk and cream. The milk is pumped into the bottom of the machine by a positive-displacement pump, and the separation is performed by centrifugal action. The cream and skim milk are forced out of separate outlets at the top of the machine.

High temperature short time pasteurizer—The high temperature short time (H. T. S. T.) pasteurizer (fig. 13) consists of a balance tank, a 3-stage, plate-type heat exchanger, and a holding tube. The pasteurizer heats the milk, holds it for 15 seconds, and cools it. A positive-displacement pump draws the milk from the balance tank and forces it through the pasteurizer and to a surge tank.

Homogenizer—The homogenizer (fig. 14) breaks down the globules of fat to such small dimensions that they remain in suspension in the milk, providing a well-mixed product without a cream layer. The milk is forced through the pasteurizer, through the homogenizer, and back through the pasteurizer by the pasteurizer pump.

Processing vats—Processing vats (fig. 15) are used for heating, pasteurizing, and cooling cream and buttermilk. The vats, which range in capacity from 50 to 1,000 gallons, are insulated, and are equipped with a close fitting cover, and a mechanical agitator.

Milk tanks—Two types of milk tanks are used in Georgia dairy plants: Mix tanks and surge tanks. Mix tanks are closed tanks used for holding or mixing milk and milk products. The tanks range in capacity from 50 to 500 gallons, are insulated, and are equipped with covers and mechanical agitators. Surge tanks are used for the storage of processed milk. The tanks may be mix-type tanks, rectangular farm-type tanks (fig. 16), or cylindrical storage-type tanks, and range widely in capacities. The tanks are closed and insulated. If used to store milk for a long period, they are equipped with mechanical agitators.

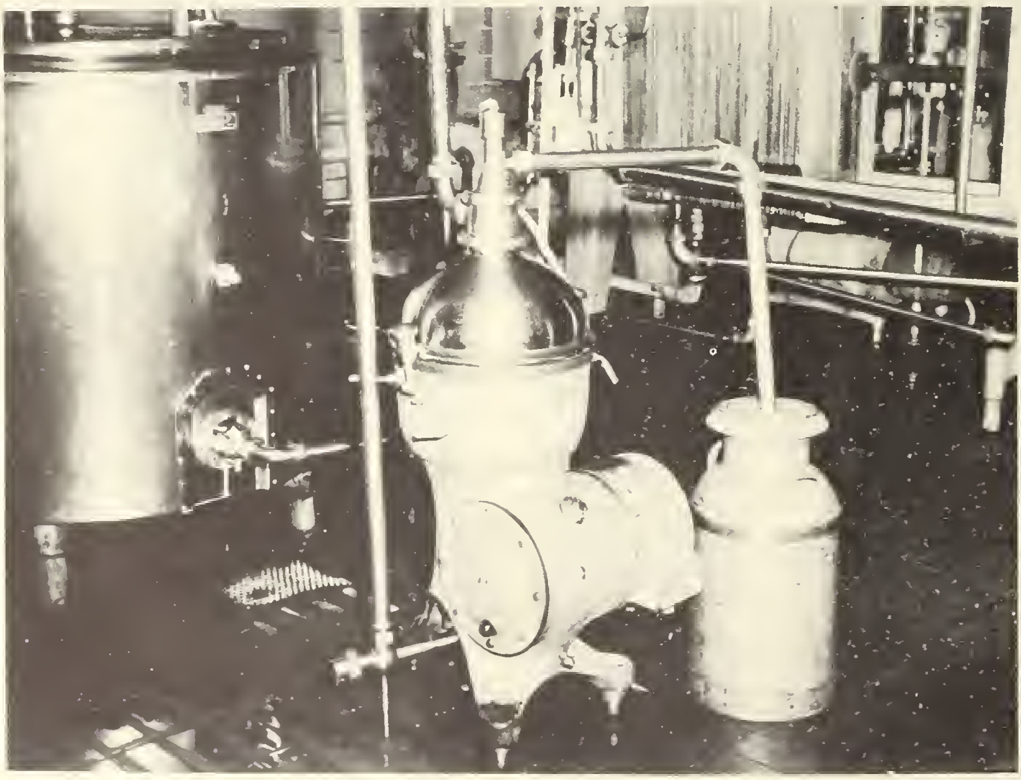

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Figure 11.—A standardizing clarifier draining excess cream into a can.

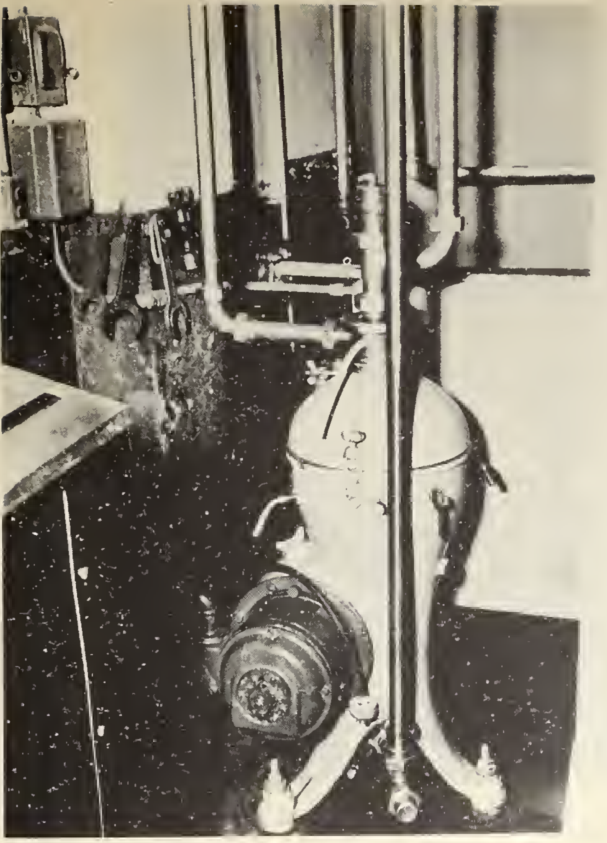

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Figure 12.—Milk enters the bottom of a separator and cream and skim milk are forced out at the top.

Piping—Milk is conducted from one item of equipment to another by 1½-inch I. D. stainless steel pipe (fig. 17).

Control panel—The control panel (fig. 18) is an instrument panel with gages which indicate the condition of the milk within the pasteurizer. In addition to gages and temperature recording devices, control panels usually house the pasteurizer start and stop buttons.

METHODS USED FOR PROCESSING MILK

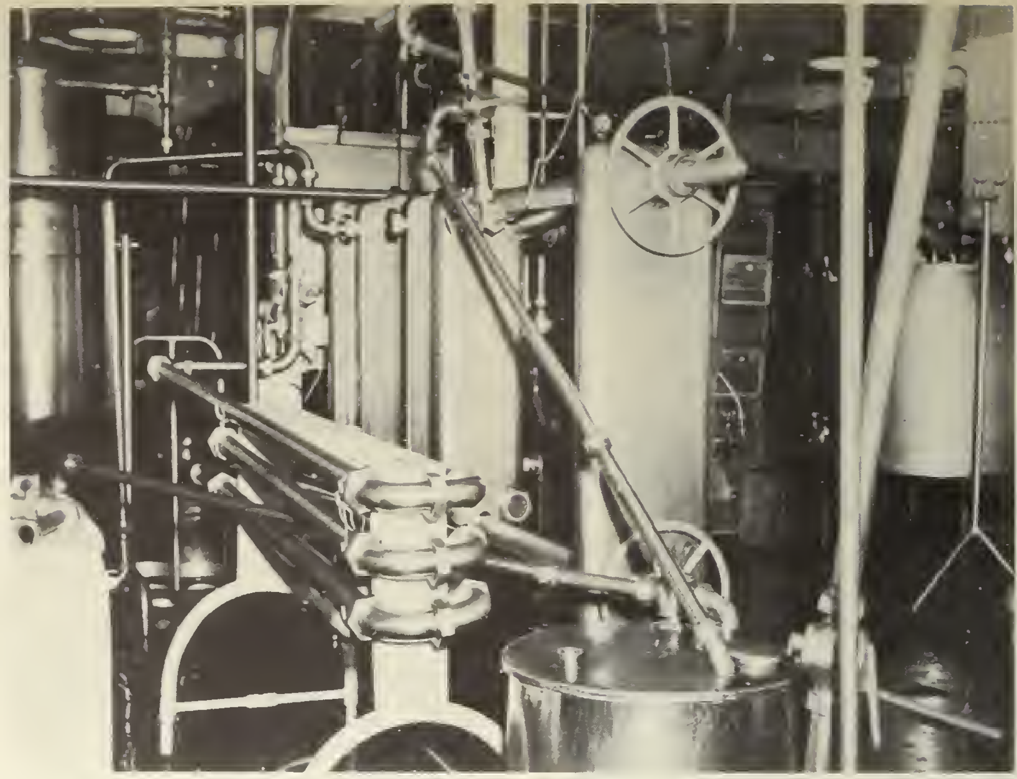
The methods and equipment employed for processing milk are basically similar in all Georgia dairy plants with a daily volume approximating 6,000 gallons. The processing of milk is primarily a machine-controlled operating cycle. Studies in Georgia dairy plants indicated that the typical plant is operating with an unbalanced system of equipment. The labor and equipment requirements for processing milk, therefore, are analyzed on the basis of processing milk with an unbalanced system of equipment and processing milk with a balanced system of equipment.

Seven operations are performed in processing milk with both the unbalanced and balanced systems of equipment. These operations are: (1) Separating milk, (2) preparing homogenized milk, (3) preparing regular milk, (4) preparing chocolate drink, (5) preparing skim milk, (6) preparing cream, and (7) preparing buttermilk. Most typical Georgia plants preparing homogenized milk, regular milk, chocolate drink, skim milk, cream, and buttermilk employ 15 items of equipment in the processing area. Most of the items of equipment in a processing room are used in the performance of more than one operation. The processing operations must be scheduled, therefore, if the maximum utilization of equipment is to be attained. The cost of each item of equipment used in an operation is based on the total volume of milk handled by the item.

PROCESSING MILK WITH AN UNBALANCED SYSTEM OF EQUIPMENT

Processing milk with an unbalanced system of equipment is based on the following items of equipment: A 5,500-pound-per-hour separator and positive-displacement pump, a 6,000-pound-per-hour standardizing clarifier and positive-displacement pump, an 8,000-pound-per-hour pasteurizer and positive-displacement pump, an 8,600-pound-per-hour homogenizer, a 10,000-pound-per hour centrifugal pump, a 2,000-gallon surge tank, a 300-gallon surge tank, a 500-gallon chocolate tank, an 800-gallon skim milk tank, a 100-gallon cream vat, a 600-gallon buttermilk vat, and 337 feet of pipe. The standardizing clarifier, the pasteurizer, and the homogenizer are all used for preparing homogenized milk, and the standardizing clarifier and pasteurizer are used for preparing regular milk. Although the most efficient rate for processing operations is 7,000 pounds per hour, the preparation of these two products is limited by the capacity of the standardizing clarifier, which is out of balance with the other equipment. These operations, therefore, must be performed at a rate of 6,000 pounds per hour. The low capacity of the standardizing clarifier does not affect the processing rates for other items of equipment; it does, however, affect the scheduling of all operations. Table 8 shows an assumed schedule for processing 6,000 gallons of milk into the previously described products with an unbalanced system of equipment.

The work crew for processing milk with an unbalanced system of equipment consists of two workers. Both workers work 8 hours a day, excluding an hour for lunch. The processing operations begin at 8 a. m. However, one worker reports for duty at 7 a. m. and devotes one hour to preparing the equipment for the day's operation. His work day ends at 4 p. m. The second worker reports for duty at 11 a. m. and his day ends at 8 p. m. The duties of workers operating machines processing milk include starting and stopping machines, checking and adjusting equipment, reading control charts, adding ingredients



BN-5618

Figure 13.—A high temperature short-time pasteurizer with the holding tube on the left and the balance tank in the foreground.

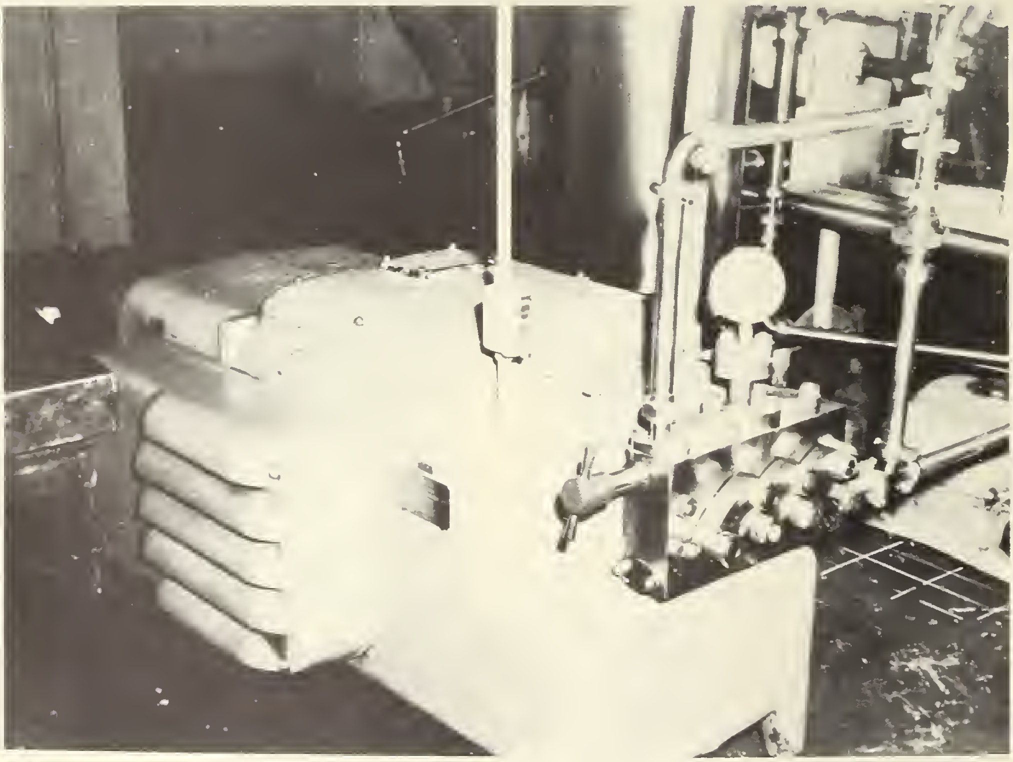


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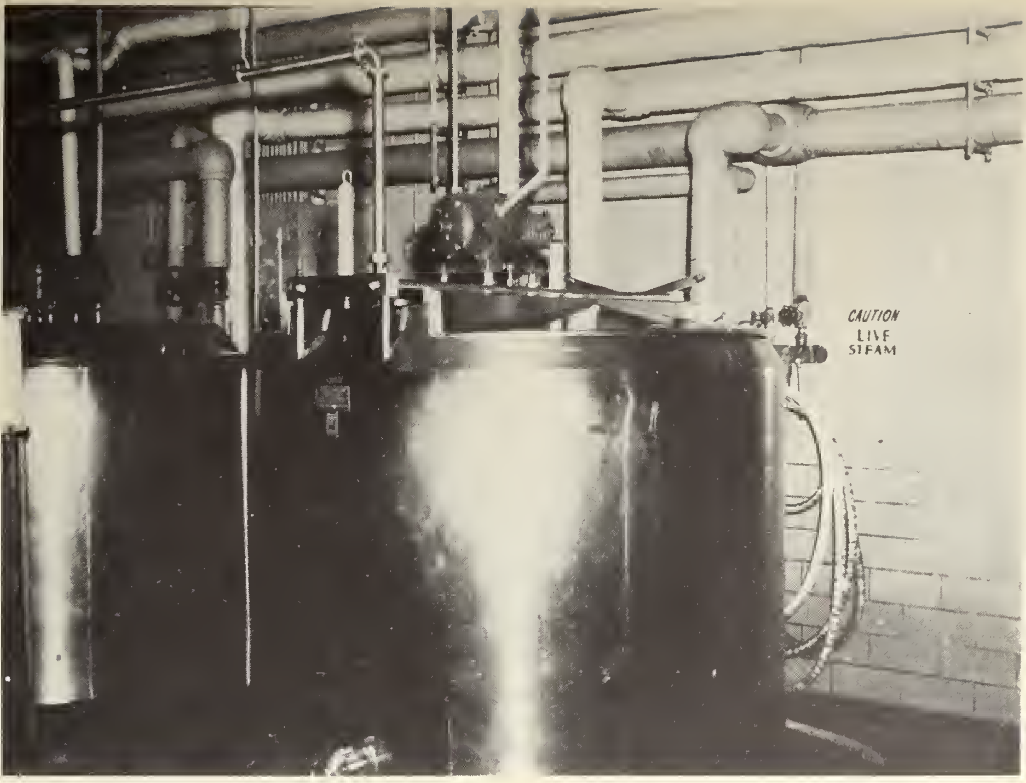
Figure 14.—The homogenizer breaks up the globules of fat and disperses the particles throughout the milk.



BN–5638

Figure 15.—Vats are used for pasteurizing buttermilk and cream.

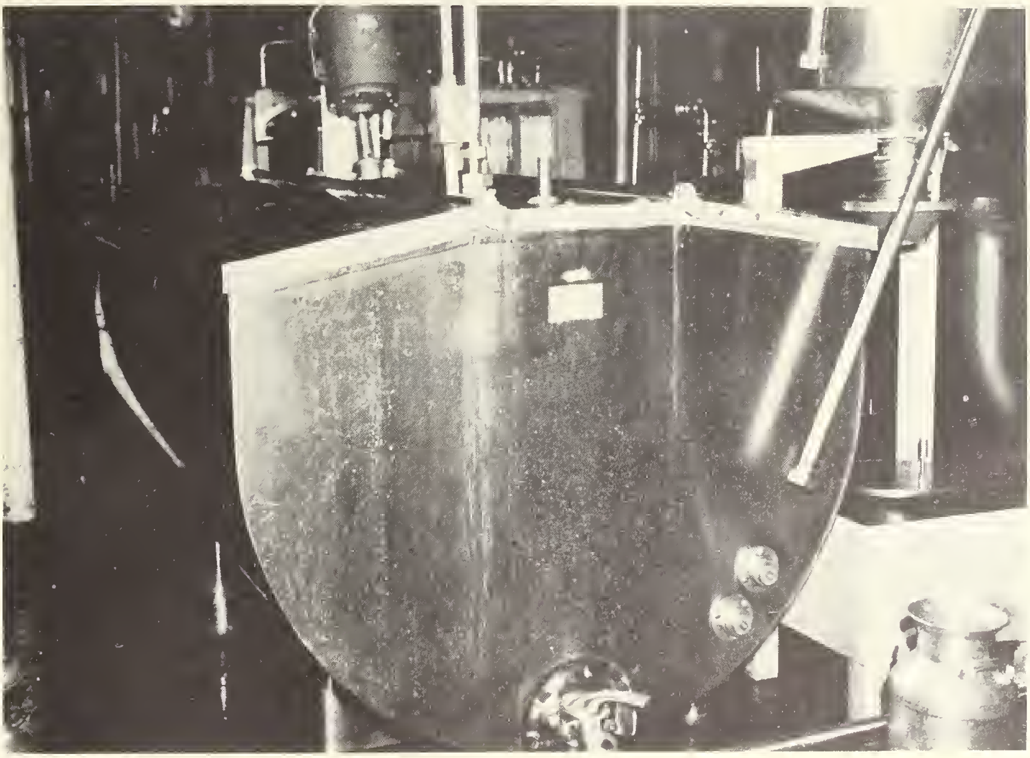


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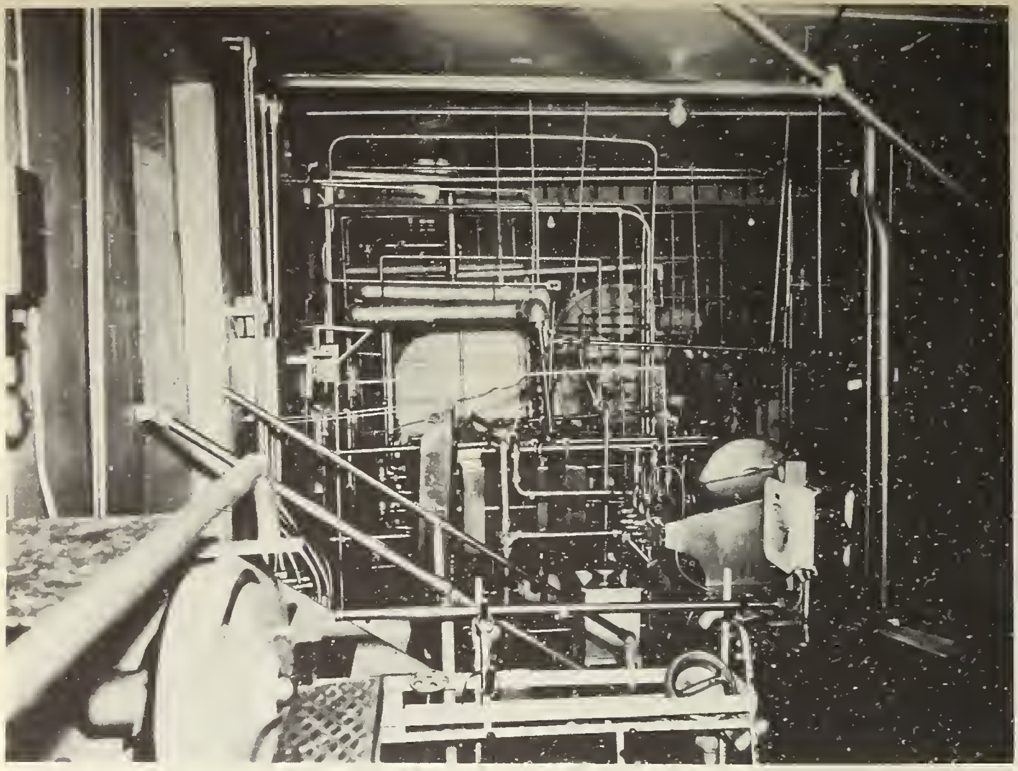
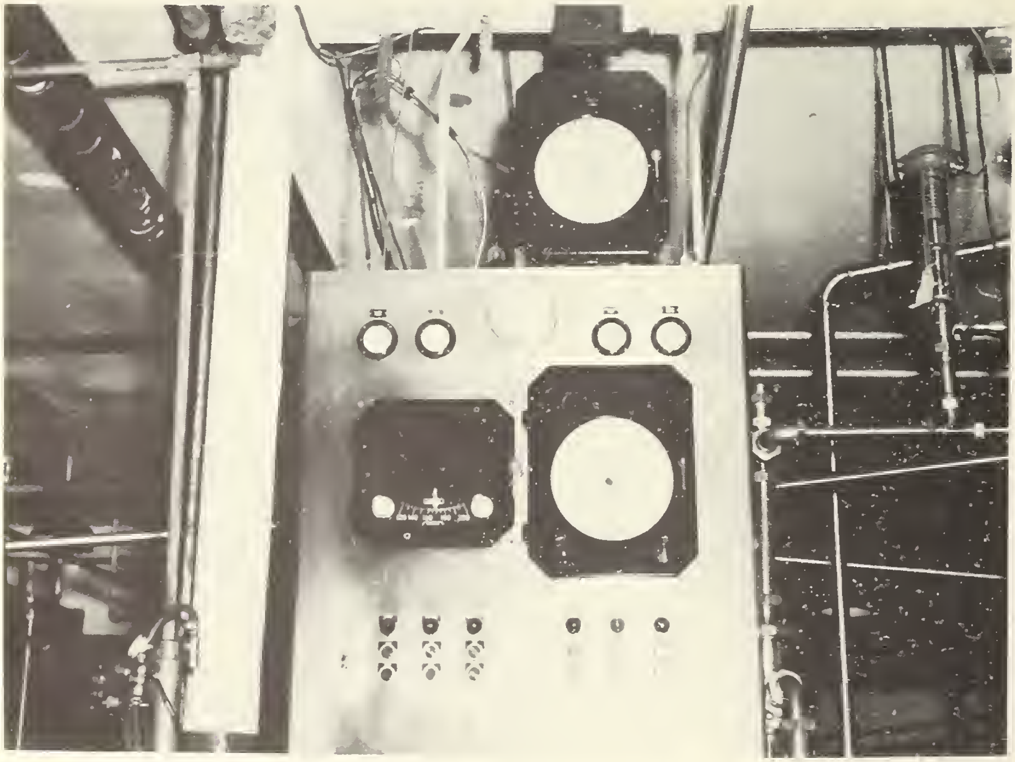
Figure 16.—The farm-type tank is used as a mix tank or a surge tank.



BN–5611

Figure 17.—A processing room with a maze of pipes, wires, and conduits.



BN–5628

Figure 18.—The instrument panel indicates the condition of the milk within the pasteurizer.

TABLE 8.—*An assumed schedule of operations for a fluid milk plant processing 6,000 gallons daily into 4,560 gallons of homogenized milk, 300 gallons of regular milk, 420 gallons of chocolate drink, 60 gallons of skim milk, 60 gallons of cream, and 600 gallons of buttermilk with an unbalanced system of equipment; equipment used by operations; and the total elapsed time per operation*

Operation	Equipment used [1]	Operating time		Elapsed time per operation	
		Start	Stop		
	Items				*Hours*
Separating milk	5,500-lb-per-hr. separator and pump (1), and piping (2).	8:00 a. m.[2]	9:47 a. m.		1. 78
Preparing homogenized milk.	6,000-lb.-per-hr. standardizing clarifier and pump (6), 8,000-lb.-per-hr. pasteurizer and pump (7), 8,600-lb.-per-hr. homogenizer (8), piping (2), 2,000-gal. surge tank (9).	9:47 a. m.[3]	2:11 p. m.	4. 40	
		3:08 p. m.[3]	3:47 p. m.	. 65	
		3:51 p. m.[3]	5:20 p. m.	1. 48	
					6. 53
Preparing regular milk.	6,000-lb.-per-hr. standardizing clarifier and pump (6), 8,000-lb.-per-hr. pasteurizer and pump (7), piping (2), 300-gal. surge tank (10).	2:11 p. m.[4]	2:37 p. m.		. 43
Preparing chocolate drink.	500-gal. chocolate tank (3), 10,000-lb.-per-hr. centrifugal pump (11), piping (2), 8,000-lb.-per-hr. pasteurizer and pump (7), 8,600-lb.-per-hr. homogenizer (8), 300-gal. surge tank (10).	8:00 a. m.[5]	8:45 a. m.	. 75	
		8:45 a. m.[6]	9:08 a. m.	. 40	
		9:08 a. m.[7]	2:37 p. m.	5. 48	
		2:37 p. m.[8]	3:08 p. m.	. 52	
		3:08 p. m.[9]	3:47 p. m.	. 65	
					7. 80
Preparing skim milk.	800-gal. skim milk tank (4), 10,000-lb.-per-hr. centrifugal pump (11), piping (2), 8,000-lb.-per-hr. pasteurizer and pump (7), 8,600-lb.-per-hr. homogenizer (8), 300-gal. surge tank (10).	8:45 a. m.[10]	3:47 p. m.	7. 03	
		3:47 p. m.[11]	3:51 p. m.	. 07	
					7. 10
Preparing cream	100-gal. cream vat (5), piping (2)	8:00 a. m.[12]	9:47 a. m.	1. 78	
		9:47 a. m.[13]	11:54 a. m.	2. 10	
		11:54 a. m.[14]	4:07 p. m.	4. 22	
					8. 10
Preparing buttermilk.	800-gal. skim milk tank (4), 600-gal. buttermilk vat (12), 10,000-lb.-per-hr. centrifugal pump (11), piping (2).	8:45 a. m.[15]	4:47 p. m.	8. 03	
		4:47 p. m.[16]	7:43 p. m.	2. 93	
		7:43 p. m.[17]	11:00 a. m.	15. 28	
		11:00 a. m.[18]	12:00 noon	1. 00	
		12:00 noon [19]	4:47 p. m.	4. 78	
					32. 02

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[1] Each item of equipment is coded to indicate the operations in which it is used.

[2] Whole milk is separated and cream is pumped to the cream vat. Skim milk is pumped first to the chocolate tank, and then to the skim milk tank.

[3] Milk is standardized, clarified, pasteurized, and homogenized at three separate times, and is then pumped to a surge tank where it is held for bottling.

[4] Milk is standardized, clarified, and pasteurized, and is then stored in a surge tank until it is bottled.

[5] Skim milk is added to the chocolate tank.

[6] Sugar and chocolate are mixed with the skim milk.

[7] The mixture is held in the tank.

[8] The mixture is pasteurized and homogenized.

[9] The chocolate drink is stored in a surge tank until it is bottled.

[10] Skim milk is added to the skim milk tank and held.

[11] Skim milk is pasteurized and held in the surge tank until it is bottled.

[12] Cream is added to the cream vat.

[13] Cream is pasteurized and cooled in the vat.

[14] Cream is stored in the vat until it is bottled.

[15] Skim milk is added to the skim milk tank and held.

[16] The buttermilk vat is cleaned, skim milk is pumped to the vat, the skim milk is pasteurized and cooled in the vat, and a lactic acid culture is added.

[17] The mixture is held while the viscosity increases.

[18] The mixture is cooled in the vat, and salt, coloring, and butterflakes are added.

[19] Buttermilk is stored in the vat until it is bottled.

to products, hauling supplies, and cleaning and reassembling items of equipment which are reused while processing is in progress. Because of the nature of the work no labor is charged for specific operations, but labor is charged for the entire operating cycle.

Separating milk—Milk is pumped from the storage tank and through the separator where it is divided into skim milk and cream. A total of 1,140 gallons of milk is separated, 1,080 gallons into skim milk and 60 gallons into cream. Four hundred and twenty gallons of skim milk are pumped into the chocolate tank and 660 gallons into the skim milk tank. The 60 gallons of cream are pumped into the cream vat. The operation is begun at 8 a. m. and completed at 9:47 a. m. The elapsed time required to separate 1,140 gallons of milk at a rate of 5,500 pounds per hour is 1.78 hours.

The equipment cost for separating 1,140 gallons of milk, based on a 5,500 pound-per-hour separator and positive displacement pump for 1.78 machine hours each, and piping for 1.56 machine hours, for a total of 5.12 machine hours is $3.12.

Preparing homogenized milk includes pumping milk from the storage tank, through the standardizing clarifier, the pasteurizer, homogenizer, and into the surge tank. A total of 4,560 gallons of milk is homogenized. Homogenized milk is processed one day, stored over night in the surge tank, and bottled from the tank the following day. Since the homogenized milk is pumped from the machines to a surge tank, the processing may be done at any time when the machinery is not being used to process other products. Thus, for the most efficient use of machines, 3 separate periods are necessary for preparing homogenized milk. These periods are from 9:47 a. m. to 2:11 p. m., from 3:08 to 3:47 p. m. and from 3:51 p. m. to 5:20 p. m. The total elapsed time required to prepare 4,560 gallons of homogenized milk at a rate of 6,000 pounds per hour is 6.53 hours.

The equipment cost for preparing 4,560 gallons of homogenized milk, based on a 6,000-pound-per-hour standardizing clarifier, a 6,000-pound-per-hour positive displacement pump, an 8,000 pound-per-hour pasteurizer, an 8,000-pound-per-hour positive-displacement pump, an 8,600-pound-per-hour homogenizer, for 6.53 machine hours each, a 2,000 gallon surge tank for 24.00 machine hours, and piping for 6.20 machine hours, for a total of 62.85 machine hours is $15.60.

Preparing regular milk involves pumping the milk from the storage tank through the standardizing clarifier, through the pasteurizer, and into the surge tank. The operating schedule for preparing regular milk is from 2:11 p. m. to 2:37 p. m. The elapsed time for preparing 300 gallons of regular milk at the rate of 6,000 pounds per hour is 0.43 hour. The equipment cost for preparing 300 gallons of regular milk, based on a 6,000-pound-per-hour standardizing clarifier, 6,000-pound-per-hour positive displacement pump, an 8,000-pound-per-hour pasteurizer, an 8,000-pound-per-hour positive-displacement pump, and a 300-gallon surge tank for 0.43 machine hours each, and piping for 0.41 machine hours, for a total of 2.56 machine hours is 91 cents.

Chocolate drink is prepared from the 420 gallons of skim milk stored in the chocolate tank when the milk was separated. The preparation of chocolate drink involves five separate periods. During the first period skim milk is stored in the chocolate tank from 8 a. m. to 8:45 a. m., an elapsed time of 0.75 hour. The second period is from 8:45 a. m. to 9:08 a. m. when sugar and chocolate are added to the skim milk and mixed. The elapsed time for this period is 0.40 hour. During the third period the chocolate drink is held in the chocolate tank from 9:08 a. m. to 2:37 p. m., an elapsed time of 5.48 hours. Between 2:37 p. m. and 3:08 p. m., the fourth period, the chocolate drink is pasteurized and homogenized and pumped into a surge tank. The elapsed time for this period is 0.52 hour. Chocolate drink is bottled from the surge tank as it is processed; however, the surge tank is not empty until 3:47 p. m. The elapsed time charged for the use of the surge tank is 0.65 hour. However, the surge tank is actually in use from 2:37 p. m. to 3:47 p. m., or 1.16 hours. The total elapsed time for preparing chocolate drink is 7.80 hours.

The equipment cost for preparing 420 gallons of chocolate drink based on a 500-gallon chocolate tank for 7.13 machine hours, a 10,000-pound-per-hour centrifugal pump, an 8,000-pound-per-hour pasteurizer, an 8,000-pound-per-hour positive displacement pump, an 8,600-pound-per-hour homogenizer for 0.52 machine-hour each, a 300 gallon surge tank for 1.16 machine hours, and piping for 0.57 machine hour, for a total of 10.94 machine hours is $1.78.

Preparing skim milk includes storing, pasteurizing and pumping skim milk into a surge tank. The milk is prepared from 60 gallons of the skim milk which was separated into the skim milk tank. The skim milk is held in the tank from 8:45 a. m. to 3:47 p. m., an elapsed time of 7.03 hours. Between 3:47 p. m. and 3:51 p. m. 60 gallons of the skim milk are drawn from the skim milk tank, pasteurized, and pumped into a surge tank. The elapsed time for pasteurizing the skim milk at a rate of 7,000 pounds per hour is 0.07 hour. Skim milk is bottled from the surge tank as it is processed, and the tank is nearly empty at the time the processing is completed. The elapsed time for preparing skim milk is 7.10 hours.

The equipment cost for preparing 60 gallons of skim milk, based on a 10,000-pound-per-hour centrifugal pump, an 8,000-pound-per-hour pasteurizer, an 8,000-pound-per-hour positive displacement pump, a 300 gallon surge tank for 0.07 machine-hour each, a skim milk tank for 7.03 machine-hours, and piping for 0.08 machine-hour, for a total of 7.39 machine-hours is 20 cents.

Preparing cream involves holding, pasteurizing, and cooling cream. The operation begins when milk is separated into skim milk and cream. The cream is held in the cream vat from 8 a. m. to 9:47 a. m., an elapsed time of 1.78 hours. Cream is pasteurized and cooled in the cream vat between 9:47 a. m. and 11:54 a. m., an elapsed time of 2.10 hours. The cream is then held in the vat until it is drawn off for bottling. The vat is empty at 4:07 p. m. The elapsed time for holding the cream is 4.22 hours. The total elapsed time for preparing cream is 8.10 hours.

The equipment cost for preparing 60 gallons of cream, based on a 100-gallon cream vat for 8.10 machine-hours, and piping for 0.08 machine-hours, for a total of 8.18 machine-hours is 66 cents.

Buttermilk is prepared from 600 gallons of the skim milk which was separated and stored in the skim milk tank. The preparation of buttermilk requires five different periods. During the first period, skim milk is stored in the skim milk tank from 8:45 a. m. to 4:47 p. m., an elapsed time of 8.03 hours. During the second period the buttermilk vat is cleaned, and the skim milk is pumped into the vat. The skim milk is pasteurized and cooled in the vat, and lactic acid culture is added. The operations are started at 4:47 p. m. and completed at 7:43 p. m. The elapsed time required is 2.93 hours.

The third period involves holding the mixture in the buttermilk vat from 7:43 p. m. to 11 a. m. the following day, while the viscosity of the mixture increases. The elapsed time is 15.28 hours. The fourth period involves recooling the mixture, and adding salt, coloring, and butterflakes. These operations are begun at 11 a. m. and are completed at 12 noon, an elapsed time of 1 hour. The fifth period involves holding the buttermilk in the vat from 12 noon to 4:47 p. m. when it is bottled. The elapsed time for storing the buttermilk is 4.78 hours. The total elapsed time for preparing buttermilk is 32.02 hours.

The equipment cost for preparing 600 gallons of buttermilk, based on an 800-gallon skim milk tank for 8.99 machine-hours, a 10,000-pound-per-hour centrifugal pump for 0.52 machine-hour, a 600-gallon buttermilk vat for 24.00 machine-hours, and piping for 0.82 machine-hour, for a total of 34.33 machine-hours, is $3.74.

Summary of requirements for processing milk with an unbalanced system of equipment. The full time of two workers is charged to processing operations. The total labor requirements for processing 6,000 gallons of milk into 4,560 gallons of homogenized milk, 300 gallons of regular milk, 420 gallons of chocolate drink, 60 gallons of skim milk, 60 gallons of cream, and 600 gallons of buttermilk is 16 man-hours. The labor requirements and costs per 1,000 gallons are 2.67 man-hours and $2.67.

The total equipment requirements for processing these 6,000 gallons are 131.37 machine-hours. The total equipment cost is $26.01. On a per 1,000 gallon basis the equipment requirements are 21.90 machine hours, and the cost is $4.34.

The labor and equipment cost, on a 1,000 gallon basis, for processing 6,000 gallons of milk with an unbalanced system of equipment is $7.01.

PROCESSING MILK WITH A BALANCED SYSTEM OF EQUIPMENT

Processing milk with a balanced system of equipment is based on the same items of equipment as those described for processing milk with an unbalanced system, with two exceptions. The 6,000-pound-per-hour standardizing clarifier and positive-displacement pump are replaced by the next larger size machines which have a rated maximum capacity of 12,000 pounds per hour. The replacement of the 6,000-pound-per-hour standardizing clarifier and positive-displacement pump with machines of greater capacity permits homogenized and regular milk to be processed at a rate of 7,000 pounds per hour (814 gallons per hour), the rate at which the processing schedule can be most efficiently balanced with the bottling schedule.

The same operations are performed in processing milk with a balanced system of equipment that are performed in processing milk with an unbalanced system of equipment. The same products and volume are also handled. However, the balancing of the equipment necessitates a different operating schedule. A schedule for processing operations for processing milk with a balanced system of equipment, and a listing of the equipment used for each operation is shown in table 9.

The number of workers used in processing milk with a balanced system of equipment is the same as that used in processing milk with an unbalanced system of equipment. The hours of work for the workers and the duties are also the same.

Separating milk—The equipment employed, the volume separated, the scheduled time, and the elapsed time for the operation is the same as that described for processing milk with an unbalanced system of equipment. The equipment cost for separating 1,140 gallons of milk, based on a 5,500 pound-per-hour separator and a 5,500 pound-per-hour positive displacement pump for 1.78 machine-hours each, and piping for 1.56 machine-hours for a total of 5.12 machine-hours is $3.12.

The preparation of homogenized milk with a balanced system of equipment is performed at two separate times, between 9:47 a. m. and 2:11 p. m., and between 3:04 p. m. and 4:16 p. m. The total elapsed time required to prepare 4,560 gallons of homogenized milk at a rate of 7,000 pounds-per-hour is 5.60 hours. The equipment cost for preparing 4,560 gallons of homogenized milk, based on a 12,000 pound-per-hour standardizing clarifier, a 12,000 pound-per-hour positive displacement pump, an 8,000 pound-per-hour pasteurizer, an 8,000 pound-per-hour positive displacement pump, an 8,600 pound-per-hour homogenizer for 5.60 machine-hours each, a 2,000 gallon surge tank for 24.00 machine-hours, and piping for 6.20 machine-hours, for a total of 58.20 machine-hours is $15.48.

The preparation of regular milk is begun at 2:11 p. m. and completed 2:33 p. m. The elapsed time required for preparing 300 gallons of regular milk at a rate of 7,000 pounds per hour is 0.37 hour. The equipment cost for preparing 300 gallons of regular milk, based on a 12,000 pound-per-hour standardizing clarifier, a 12,000 pound-per-hour positive displacement pump, an 8,000 pound-per-hour pasteurizer, an 8,000 pound-per-hour positive displacement pump, and a 300 gallon surge tank for 0.37 machine-hour each, and piping for 0.41 machine-hour, for a total of 2.26 machine-hours is 91 cents.

Table 9.—*An assumed schedule of operations for a fluid milk plant processing 6,000 gallons daily into 4,560 gallons of homogenized milk, 300 gallons of regular milk, 420 gallons of chocolate drink, 60 gallons of skim milk, 60 gallons of cream, and 600 gallons of buttermilk with a balanced system of equipment; equipment used, by operations, and the total elapsed time per operation*

Operation	Equipment used [1]	Operating time		Elapsed time per operation	
		Start	Stop		
	Items			*Hours*	
Separating milk	5,500-lb.-per-hr. separator and pump (1), piping (2).	8:00 a. m.[2]	9:47 a. m.		1.78
Preparing homogenized milk.	12,000-lb.-per-hr. standardizing clarifier and pump (6), 8,000-lb.-per-hr. pasteurizer and pump (7), 8,600-lb.-per-hr. homogenizer (8), piping (2), 2,000-gal. surge tank (9).	9:47 a. m.[3]	2:11 p. m.	4.40	
		3:04 p. m.[3]	4:16 p. m.	1.20	
					5.60
Preparing regular milk.	12,000-lb.-per-hr. standardizing clarifier and pump (6), 8,000-lb.-per-hr. pasteurizer and pump (7), piping (2), 300-gal. surge tank (10).	2:11 p. m.[4]	2:33 p. m.		.37
Preparing chocolate drink.	500-gal. chocolate tank (3), 10,000-lb.-per-hr. centrifugal pump (11), piping (2), 8,000-lb.-per-hr. pasteurizer and pump (7), 8,600-lb.-per-hr. homogenizer (8), 300-gal. surge tank (10).	8:00 a. m.[5]	8:45 a. m.	.75	
		8:45 a. m.[6]	9:08 a. m.	.40	
		9:08 a. m.[7]	2:33 p. m.	5.42	
		2:33 p. m.[8]	3:04 p. m.	.52	
		3:04 p. m.[9]	3:43 p. m.	.63	
					7.72
Preparing skim milk.	800-gal. skim milk tank (4), 10,000-lb.-per-hr. centrifugal pump (11), piping (2), 8,000-lb.-per-hr. pasteurizer and pump (7), 300-gal. surge tank (10).	8:45 a. m.[10]	4:16 p. m.	7.52	
		4:16 p. m.[11]	4:20 p. m.	.07	
					7.59
Preparing cream	100-gal. cream vat (5), piping (2)	8:00 a. m.[12]	9:47 a. m.	1.78	
		9:47 a. m.[13]	11:54 a. m.	2.10	
		11:54 a. m.[14]	3:59 p. m.	4.07	
					7.95
Preparing buttermilk.	800-gal. skim milk tank (4), 600-gal. butter milk vat (12), 10,000-lb.-per-hr. centrifugal pump (11), piping (2).	8:45 a. m.[15]	5:00 p. m.	8.25	
		5:00 p. m.[15]	7:56 p. m.	2.93	
		7:56 p. m.[17]	11:13 a. m.	15.28	
		11:13 a. m.[18]	12:13 p. m.	1.00	
		12:13 p. m.[19]	5:00 p. m.	4.78	
					32.24

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[1] Each item of equipment is coded to indicate the operations in which it is used.

[2] Whole milk is separated and cream is pumped to the cream vat. Skim milk is pumped first to the chocolate tank, and then to the skim milk tank.

[3] Milk is standardized, clarified, pasteurized, and homogenized, at two separate times, and is then pumped to a surge tank where it is held for bottling.

[4] Milk is standardized, clarified, and pasteurized, and is then stored in a surge tank until it is bottled.

[5] Skim milk is added to the chocolate tank.

[6] Sugar and chocolate are mixed with the skim milk.

[7] The mixture is held in the tank.

[8] The mixture is pasteurized and homogenized.

[9] The chocolate drink is stored in a surge tank until it is bottled.

[10] Skim milk is added to the skim milk tank and held.

[11] Skim milk is pasteurized and held in the surge tank until it is bottled.

[12] Cream is added to the cream vat.

[13] Cream is pasteurized and cooled in the vat.

[14] Cream is stored in the vat until it is bottled.

[15] Skim milk is added to the skim milk tank and held.

[15] The buttermilk vat is cleaned, skim milk is pumped to the vat, the skim milk is pasteurized and cooled in the vat, and a lactic acid culture is added.

[17] The mixture is held while the viscosity increases.

[18] The mixture is cooled in the vat, and salt, coloring, and butterflakes are added.

[19] Buttermilk is stored in the vat until it is bottled.

Chocolate drink is prepared with a balanced system of equipment in the same manner as that described for an unbalanced system. However, the schedule and the total elapsed time required for preparing chocolate drink with a balanced system of equipment are changed (table 9). The total elapsed time required for preparing chocolate drink with a balanced system of equipment is 7.72 hours.

The equipment cost for preparing 420 gallons of chocolate drink, based on an 8,000 pound-per-hour pasteurizer, an 8,000 pound-per-hour, positive displacement pump, a 10,000 pound-per-hour centrifugal pump, and an 8,600 pound-per-pound homogenizer for 0.52 machine hour each, a 500 gallon chocolate tank for 7.07 machine-hours, a 500 gallon surge tank for 1.16 machine-hours, and piping for 0.57 machine-hour, for a total of 10.88 machine-hours is $1.73.

Skim milk is prepared with a balanced system of equipment in the same manner in which it is prepared with an unbalanced system. The schedule and the total elapsed time required for preparing skim milk with a balanced system of equipment are changed. The total elapsed time required for preparing skim milk with a balanced system of equipment is 7.59 hours.

The equipment cost for preparing 60 gallons of skim milk, based on a 10,000 pound-per-hour centrifugal pump, an 8,000 pound-per-hour pasteurizer, an 8,000 pound-per-hour positive displacement pump, and a 300 gallon surge tank for 0.07 machine-hour each, an 800 gallon skim milk tank for 7.52 machine-hours, and piping for 0.08 machine-hour, for a total of 7.88 machine-hours is $0.20.

Cream is prepared with a balanced system of equipment in the same manner as that used with an unbalanced system. The schedule and the total elapsed time required for preparing cream with a balanced system of equipment, however, are changed. The total elapsed time required for preparing cream with a balanced system of equipment is 7.95 hours.

The equipment cost for preparing 60 gallons of cream, based on a 100 gallon cream vat for 7.97 machine-hours and piping for 0.08 machine-hours, for a total of 8.05 machine-hours is $0.66.

Buttermilk is prepared with a balanced system of equipment in the same manner in which it is prepared with an unbalanced system of equipment. The schedule and the total elapsed time required for preparing buttermilk with a balanced system of equipment, however, are changed. The total elapsed time required for preparing buttermilk with a balanced system of equipment is 32.24 hours.

The equipment cost for preparing 600 gallons of buttermilk, based on an 800 gallon skim milk tank for 9.21 machine-hours, a 600 gallon buttermilk vat for 24 machine-hours, a 10,000 pound-per-hour centrifugal pump for 0.52 machine-hour and piping for 0.82 machine-hour, for a total of 34.55 machine-hours is $3.74.

Summary of requirements for processing milk with a balanced system of equipment—The total labor requirements for processing 6,000 gallons of milk into 4,560 gallons of homogenized milk, 300 gallons of regular milk, 420 gallons of chocolate drink, 60 gallons of skim milk, 60 gallons of cream, and 600 gallons of buttermilk with a balanced system of equipment is 16 man-hours. The total labor cost is $16. The labor requirement per 1,000 gallons is 2.67 man-hours and the labor cost is $2.67.

The total equipment requirements are 126.94 machine hours, and the equipment cost is $25.84. On a per 1,000 gallons basis the equipment requirement are 21.16 machine hours and the cost is $4.31.

The total labor and equipment cost, on a 1,000 gallon basis, for processing 6,000 gallons of milk with a balanced system of equipment is $6.98.

COMPARISON OF REQUIREMENTS FOR PROCESSING MILK WITH AN UNBALANCED AND WITH A BALANCED SYSTEM OF EQUIPMENT

The total labor and equipment cost per 1,000 gallons for processing 6,000 gallons of milk with an unbalanced system of equipment is $7.01 as compared with $6.98 for processing milk with a balanced system of equipment (table 10).

The reason for the negligible effect of the change on the cost may be traced to the relatively high ownership costs of milk-processing equipment. Replacement of the standardizing clarifier and pump by higher capacity machines reduces the operating time and cost of the homogenizer and the pasteurizer and pump. The reduced costs, however, are essentially nullified by the increase in ownership costs associated with the use of a higher capacity standardizing clarifier and pump.

TABLE 10.—*Comparison of labor and equipment requirements and costs per 1,000 gallons for processing 6,000 gallons of milk with an unbalanced and with a balanced system of equipment, with a crew of two workers* [1]

Method	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Processing milk with an unbalanced system of equipment	2. 67	21. 90	2. 67	4. 34	7. 01
Processing milk with a balanced system of equipment	2. 67	21. 16	2. 67	4. 31	6. 98

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[1] Based on processing 6,000 gallons of milk into 4,560 gallons of homogenized milk, 300 gallons of regular milk, 420 gallons of chocolate drink, 60 gallons of skim milk, 60 gallons of cream, and 600 gallons of buttermilk.

EQUIPMENT AND METHODS FOR BOTTLING MILK

For the purposes of measuring the relative labor and equipment requirements of various methods of bottling and packaging milk it is assumed that a fluid milk plant handling 6,000 gallons of milk a day would bottle 4,800 gallons and package 1,200 gallons in cans. The packaging of milk in cans is discussed in the following section of this report.

Georgia dairy plants bottle milk in two types of containers, glass bottles and paper cartons. Most of the plants bottle either entirely in paper cartons, or use both paper and glass. Because of the almost exclusive use of cartons for wholesale distribution, very few plants bottle milk only in glass. The products bottled are the same as those processed.

The assumed product distribution by container sizes for bottling 4,800 gallons of milk is shown in table 11. The container sizes used are quarts, pints, and half-pints. Other container sizes, such as half-gallons and third-quarts, were not found in the majority of Georgia plants, and are not considered in this analysis.

Table 11.—*An assumed product distribution by container sizes for bottling 4,800 gallons of milk for a 6,000-gallon-per-day plant.*

Product	Volume	Container size		
		Quarts	Pints	Half-pints
	Gallons	*Number*	*Number*	*Number*
Homogenized milk	2, 730	10, 920		
Do	300		2, 400	
Do	330			5, 280
Regular milk	300	1, 200		
Chocolate drink	210	840		
Do	210			3, 360
Skim milk	60	240		
Cream	60			960
Buttermilk	600	2, 400		
Total	4, 800	15, 600	2, 400	9, 600

EQUIPMENT USED FOR BOTTLING MILK

The types of equipment used for bottling milk in either glass or paper containers are basically the same for plants in Georgia handling approximately 6,000 gallons of milk a day.

Conveyors—Two types of conveyors are used for milk bottling operations, case conveyors and bottle conveyors. The case conveyor is a power-driven conveyor similar to the type used in can receiving rooms. The conveyor originates at the case receiving station on the dock, passes through the case washing room, the bottling room, and the cooler, and terminates at the case loading station on the dock.

The bottle conveyor (fig. 19) conducts glass bottles from the bottle washer to the bottle filler. It is a stainless steel power conveyor, and is equipped with side rails and a hood.

Case washer—A case washer (fig. 20) is mounted over the conveyor, and cases are automatically sprayed with a wash solution and rinsed as they travel through the washer.

Bottle washer—Dirty bottles are placed in individual compartments of an automatic bottle washer by a worker (fig. 21). The bottles are then prerinsed, soaked, washed by a jet spray or a brush, rinsed, and discharged onto the bottle conveyor.

Centrifugal pump—Centrifugal pumps are used for pumping milk to bottle filling machines. The pumps used for this purpose are identical to those employed in the processing operations.

Carton machine—The carton machine (figs. 22 and 23) forms the cartons and fills them with milk. The flat, pre-cut, and pre-creased cartons are loaded into the machine by the worker. The cartons are then automatically formed, glued, coated with wax, filled, closed, stapled, coded, and discharged onto the accumulating table.

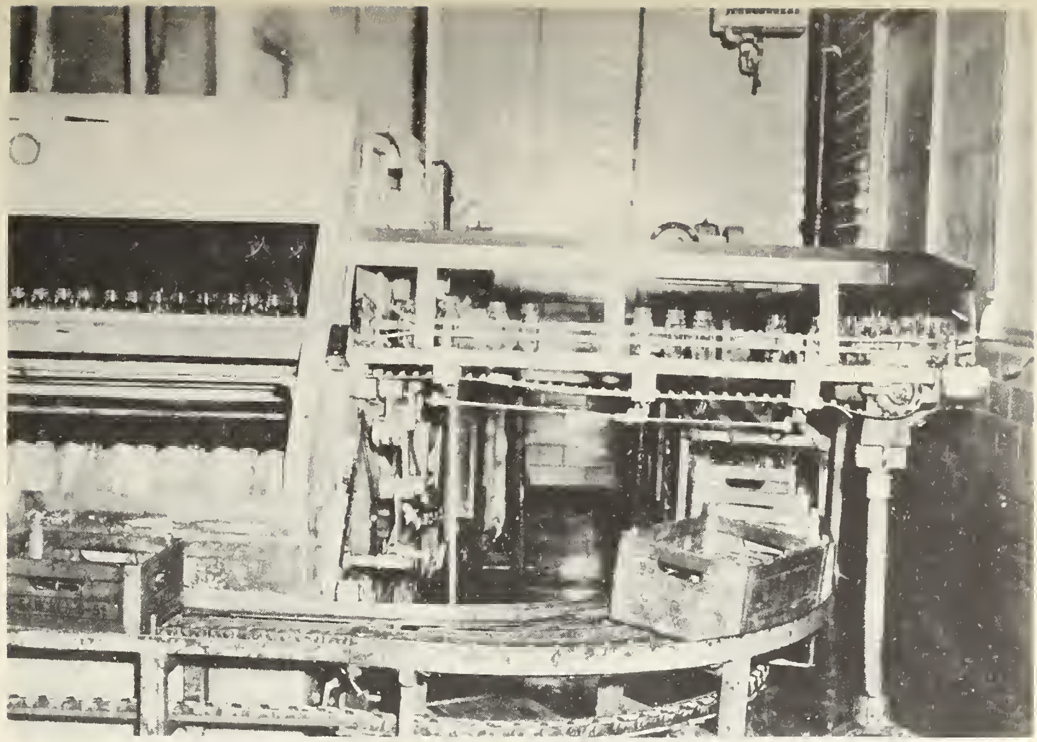
Bottle filler—The glass bottle filler (fig. 24) consists of a tank or filler bowl with a variable number of filling valves attached, a bottle conveying system, a bottle capper, and an accumulating table. Empty bottles are conducted to the filler, raised to the valves and filled as the bowl slowly revolves (fig. 25), conveyed to the capper and capped as the mechanism revolves, and then discharged to the accumulating table.

METHODS USED FOR BOTTLING MILK

The methods employed for bottling milk in either paper or glass containers are primarily dependent upon the types of equipment used, and are basically similar in the majority of Georgia fluid milk plants. The methods used for bottling milk, therefore, are discussed on the basis of bottling milk in paper and glass and bottling milk in paper. In analyzing the labor and equipment requirements for various methods used in bottling milk, the relative costs of cartons, bottles, cases, and other supplies are not considered.

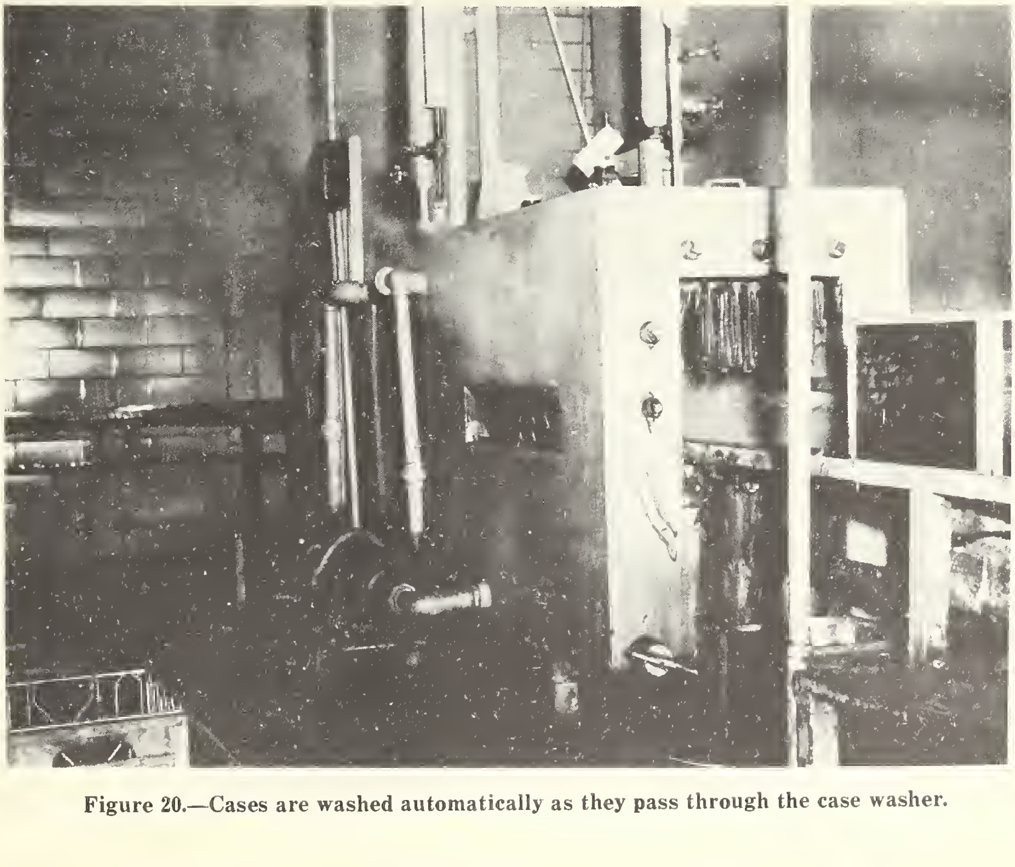
BOTTLING MILK IN PAPER AND GLASS

For the purpose of this analysis it is assumed that 50 percent of the volume is bottled in paper and 50 percent is bottled in glass. Thus this analysis is based on bottling 2,400 gallons of milk in paper and 2,400 gallons in glass. The bottling of milk in paper and glass is based on filing 7,800 quarts, 1,200 pints, and 4,800 half-pints in each type of container.



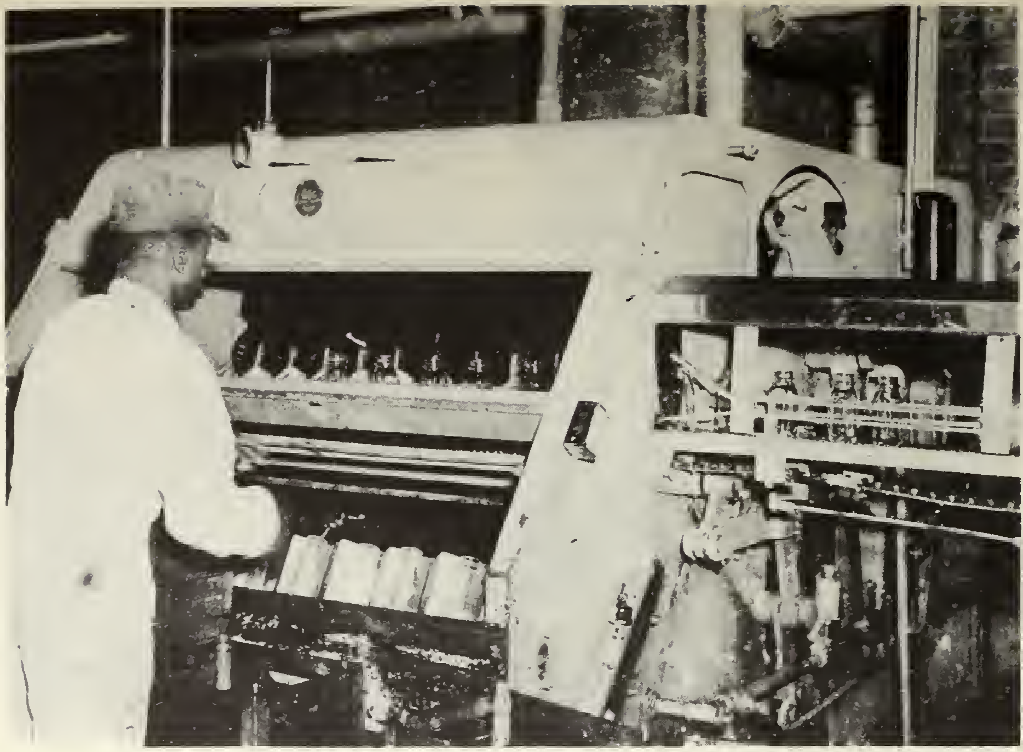
BN-5635

Figure 19.—A covered conveyor conducts clean bottles from the washer to the filler.



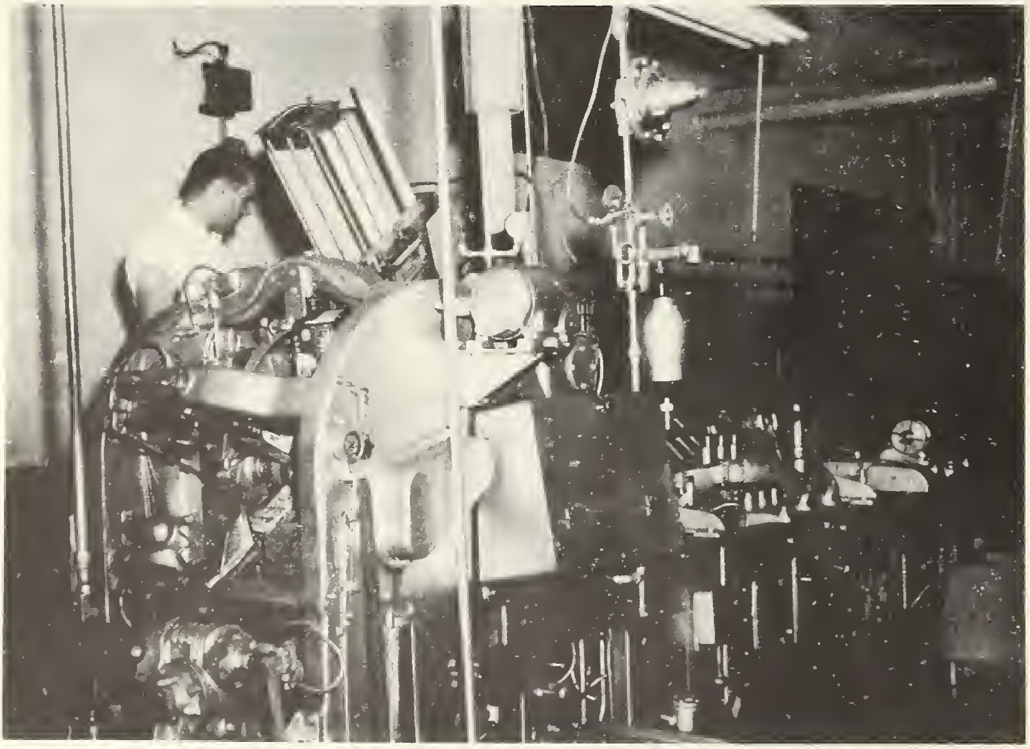
BN-5636

Figure 20.—Cases are washed automatically as they pass through the case washer.



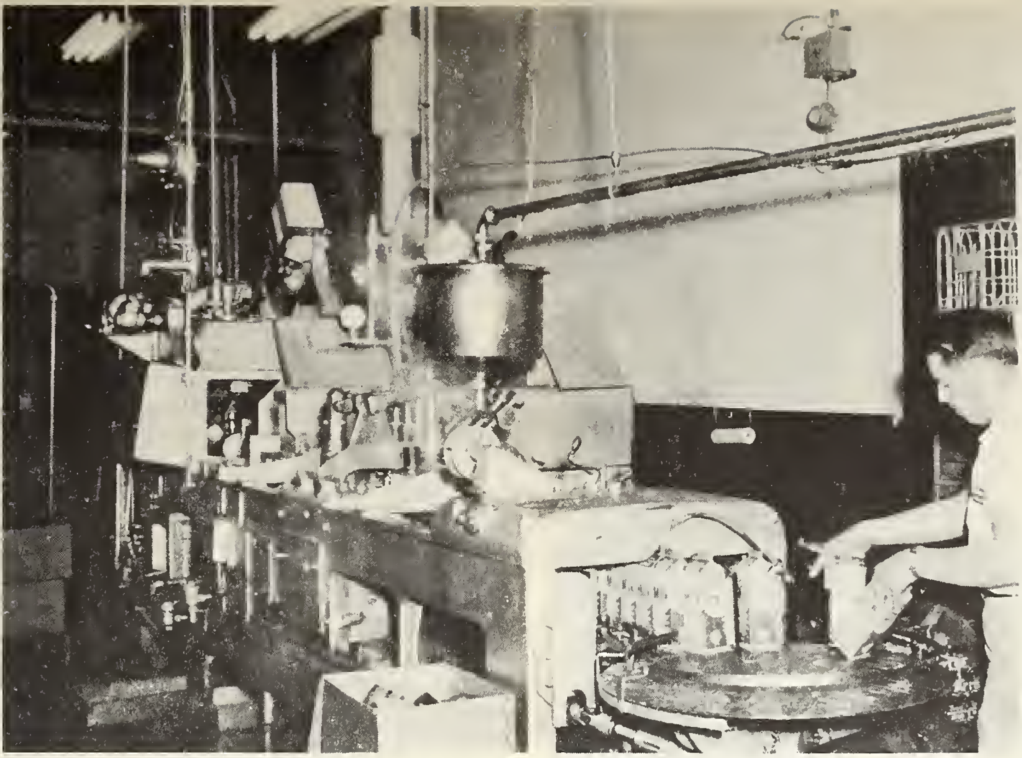
BN—5630

Figure 21.—Dirty bottles are placed in the washer by a worker, and then washed and discharged onto the bottle conveyor.



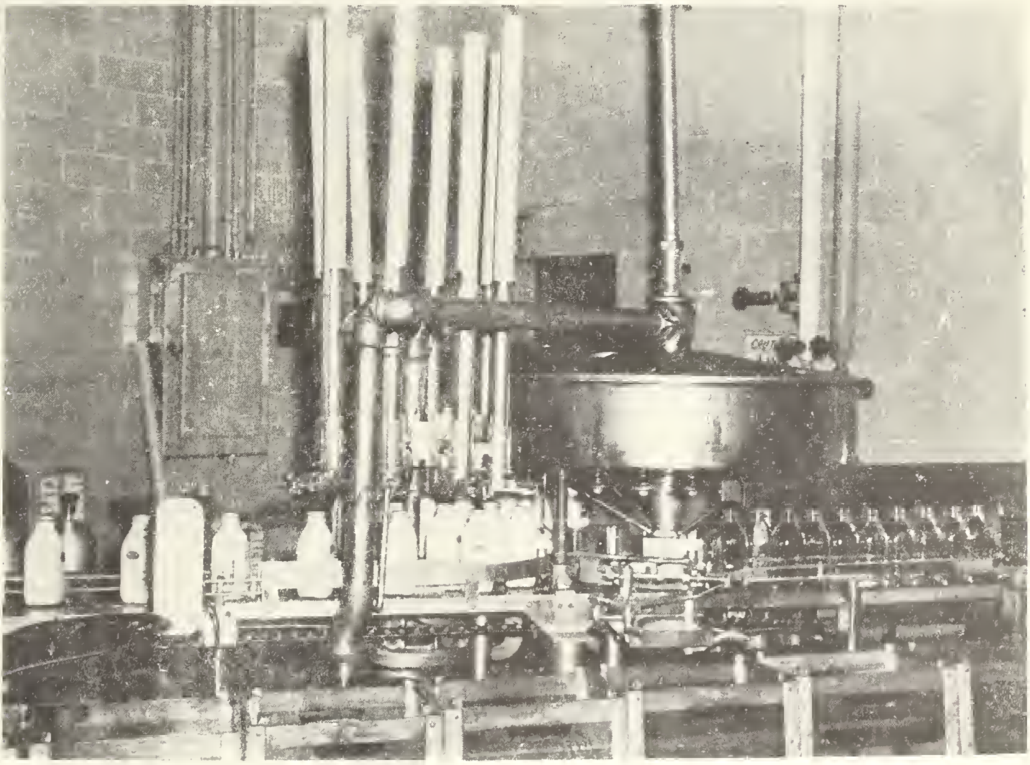
BN—5634

Figure 22.—Empty cartons are loaded into a carton machine by the worker.



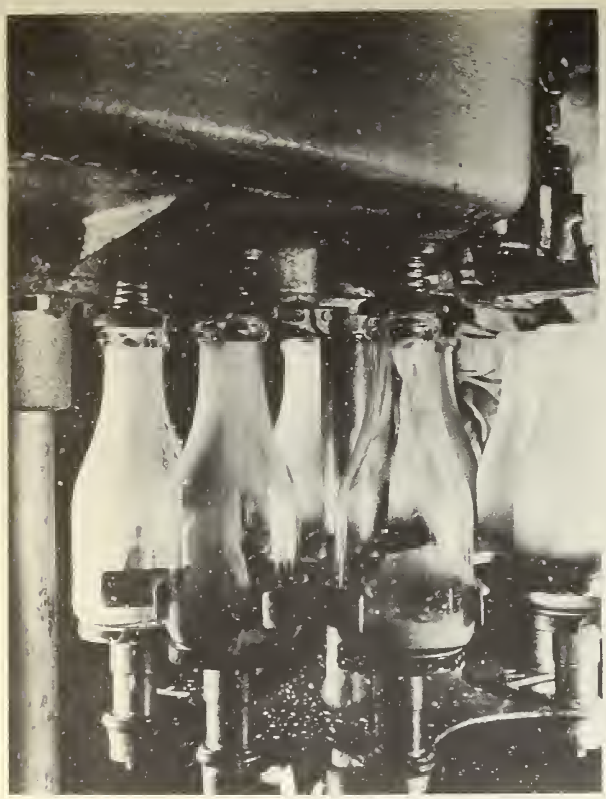
BN–5629

Figure 23.—Filled cartons being discharged from a carton machine.



BN–5632

Figure 24.—Glass bottles are filled from the filler bowl and then capped by a revolving bottle capper.



BN—5609

Figure 25.—As the filling machine slowly revolves, the valve platforms rise and the bottles force open the valves.

Milk is packaged in paper cartons and glass bottles simultaneously, both operations beginning at 8 a. m. Empty cases are supplied to both machines from the case room during the entire bottling period, and empty bottles are supplied to the bottle filler from the bottle washer during the glass bottling period. The operations involved in bottling milk in paper and glass are: (1) Receiving and handling cases; (2) washing bottles; (3) pumping milk to bottling machines; (4) filling paper cartons; (5) casing paper cartons; (6) filling glass bottles; and (7) casing glass bottles.

Most fluid milk plants bottle milk products by a schedule. The assumed schedule for the purposes of determining bottling labor and equipment requirements for bottling 2,400 gallons of milk in glass and in paper is shown in table 12. The bottling rate is synchronized with a rate for processing milk at 7,000 pounds per hour with a balanced system of equipment. Bottling milk in paper and glass requires a crew of 7 workers, 2 for receiving and handling cases, 1 for washing bottles, 2 for filling containers, and 2 for casing containers.

Receiving and handling cases—Two types of cases are received and handled in bottling milk in paper and glass. These types are empty carton cases, and cases of empty bottles. Empty carton cases and cases of empty bottles are unloaded at the truck dock by the truckdriver and placed on a power conveyor. The cases are then transported into the case room where trash is removed from the cases and the cases are stacked in a storage

Table 12.—*An assumed schedule for bottling 2,400 gallons of milk in paper and 2,400 gallons in glass when the product distribution for each is 1,680 gallons of homogenized milk, 150 gallons of regular milk, 210 gallons of chocolate drink, 30 gallons of skim milk, 30 gallons of cream, and 300 gallons of buttermilk; and the elapsed time for bottling each product.*

Product	Bottling in paper cartons [1]			Bottling in glass bottles [2]		
	Start	Stop	Elapsed time	Start	Stop	Elapsed time
			Hours			*Hours*
Homogenized milk	8:00 a. m.	12 noon	4.00	8:00 a. m.	12 noon	4.00
	1:00 p. m.[3]	1:19 p. m.	.31	1:00 p. m.[3]	1:22 p. m.	.37
Regular milk	1:19 p. m.	1:36 p. m.	.28	1:22 p. m.	1:40 p. m.	.30
Chocolate drink	1:36 p. m.	2:34 p. m.	.97	1:40 p. m.	2:36 p. m.	.94
Skim milk	2:34 p. m.	2:38 p. m.	.06	2:36 p. m.	2:40 p. m.	.06
Cream	2:38 p. m.	2:51 p. m.	.22	2:40 p. m.	2:53 p. m.	.22
Buttermilk	2:51 p. m.	3:25 p. m.	.56	2:53 p. m.	3:30 p. m.	.61
Total elapsed time			6.40			6.50

[1] Based on a 45-carton-per-minute carton machine with an operating efficiency of 80 percent. The operating efficiency allows for time lost due to machine breakdowns, faulty cartons, and changes of products and container sizes.

[2] Based on a 48-quart-per-minute bottle filler with an operating efficiency of 70 percent. The operating efficiency allows for time lost due to machine breakdowns, bottle jams, changes of products and bottle sizes, and adding caps.

[3] Allowance is made for a 1-hour lunch period.

area. Subsequently, cases of empty bottles are reloaded on the power conveyor and conveyed past the bottle washer, where the bottles are removed; the cases are then conveyed through a case washer and into the bottling room. The empty carton cases are reloaded on the power conveyor, conveyed through a case washer, and into the bottling room.

Two workers are required to perform the operation. One worker loads cases on the two conveyors. This worker works from 8 a. m. to 3:30 p. m.—the full period of the bottling operation. The other worker removes caps and straws from milk bottles during the morning, and stacks the various-sized cases in assigned areas as they are received from trucks. This worker works from 8 a. m. to 5 p. m. Since both loading cases on the conveyors and receiving cases from the trucks are performed at irregular intervals, the two workers are not productive during their entire working periods. They cannot, however, be assigned to work outside the room. The labor requirements, therefore, must be based upon the total working periods, which include both productive and nonproductive time. Thus the total labor required for receiving and handling cases in a plant bottling 4,800 gallons of milk a day in paper and glass is 14.5 man-hours. The labor requirements per 1,000 gallons are 3.02 man-hours.

The equipment cost of receiving and handling cases, based on a 140-foot paper case conveyer and a 140-foot glass case conveyor for a total of 3.33 machine-hours, and two 10-case per minute case washers for a total of 2.92 machine-hours, for a grand total of 6.25 machine-hours, is $1.09 per 1,000 gallons of milk. The labor cost is $3.02 per 1,000 gallons of milk. The total equipment and labor cost for receiving and handling cases per 1,000 gallons of milk is $4.11.

Washing bottles includes removing empty bottles from the cases, placing them in separate compartments of the automatic washer, cleaning bottles, and discharging the clean bottles onto the bottle conveyor. The washer is set to operate at a rate corresponding to that of the bottle filler, and operates 6.5 hours per day. The cases en route to the bottle filler pass directly in front of the washer.

One worker performs the operation. He removes the bottles from the case and places them in the washer. He is also responsible for cleaning the washer, which requires 0.7 hour. The total labor required for washing bottles, including the time required for cleaning the washer, is 7.20 man-hours for bottling 2,400 gallons of milk. The labor requirements per 1,000 gallons for washing bottles for bottling 2,400 gallons of milk in glass is 3 man-hours, and the labor cost is $3. The equipment cost based on a 55-bottle-per-minute bottle washer for 2.71 machine-hours is $2.29. The total labor and equipment cost per 1,000 gallons for washing bottles for bottling 2,400 gallons of milk in glass is $5.29.

For bottling 4,800 gallons of milk in paper and glass, the labor and equipment requirements are 1.50 man-hours and 1.35 machine-hours per 1,000 gallons. The labor cost is $1.50 and the equipment cost, $1.15. The total labor and equipment cost is $2.65.

Pumping milk to bottling machines involves pumping the processed milk from the surge tanks and vats to the bottling machines, and occurs during the entire bottling periods. The equipment required for the performance of the operation is two 10,000-pound-per-hour centrifugal pumps. No labor is involved in the operation. The equipment cost per 1,000 gallons for pumping the milk to the bottling machines, based on two 10,000-pound-per-hour centrifugal pumps for a total of 2.67 machine-hours, is 8 cents.

Filling paper cartons includes forming, gluing, waxing, filling, closing, stapling, coding, and discharging the cartons. The operation is completely automatic. Studies of Georgia plants indicate that carton machines operate at an efficiency of 80 percent. On this basis, a 45-carton-per-minute machine fills 36 cartons per minute, regardless of the carton size. The operating efficiency of 80 percent allows for the time lost due to machine breakdowns, faulty cartons, and changes of products and container sizes. On the basis of the assumed schedule of operations for bottling homogenized milk, regular milk, chocolate drink, skim milk, cream, and then buttermilk, the total time required for bottling 2,400 gallons of milk in paper is 6.4 hours.

One worker is responsible for operating the machine. Carton machine operators devote approximately 23 percent of their time to adding carton blanks, wax, glue, and wire to the machine, and oiling and greasing the machine. The remainder of the worker's time is devoted to watching the machine for faulty cartons and making occasional adjustments. The worker is also required to spend 0.6 hour each morning prior to the bottling period rinsing and lubricating the machine. The total labor required for filling 2,400 gallons of milk in paper cartons is 7 man-hours, including the time required for preparing the machine. The labor required per 1,000 gallons for filling 2,400 gallons of milk in paper cartons is 2.92 man-hours, and the labor cost is $2.92. The equipment cost, based on a 45-carton-per-minute carton machine for 2.67 machine-hours is $9.40. The total labor and equipment cost per 1,000 gallons for bottling 2,400 gallons in paper cartons is $12.32.

On the basis of bottling 4,800 gallons of milk in paper and glass the labor and equipment requirements are 1.46 man-hours and 1.34 machine-hours per 1,000 gallons. The labor cost is $1.46 and the equipment cost is $4.70. The total labor and equipment cost is $6.16.

Casing paper cartons involves removing the cartons from the accumulating table and placing them in cases. The cases are brought directly from the case storage area to the accumulating table by a conveyor. The total time required for casing paper cartons for 2,400 gallons of milk bottled in paper is 6.4 hours. One worker performs the operation. The total labor required for casing paper cartons for bottling 2,400 gallons of milk in paper is 6.4 man-hours. The labor required per 1,000 gallons for casing 2,400 gallons of milk in paper cartons is 2.67 man-hours and the labor cost, $2.67. The equipment cost based on a 140-foot paper case conveyor for 2.67 machine-hours is 15 cents. The total labor and equipment cost is $2.82.

On the basis of bottling 4,800 gallons of milk in paper and glass the labor and equipment requirements per 1,000 gallons are 1.34 man-hours and 1.34 machine-hours. The labor cost is $1.34 and the equipment cost is 8 cents. The total labor and equipment cost is $1.42.

Filling glass bottles includes filling, capping, and discharging bottles. The operation is automatic. The bottle filler operates at a rate of 48 quarts per minute and 55 pints or half-pints per minute. Studies in Georgia dairy plants indicate that glass bottling machines operate at an efficiency of 70 percent. On this basis a 48-quart-per-minute bottle filler fills bottles at a rate of 34 quarts per minute. The operating efficiency of 70 percent allows for machine breakdowns, bottle jams, changing bottle sizes, changing products, and adding caps.

The total time required to bottle 2,400 gallons of milk in glass is 6.5 hours. One worker operates the machine. He is responsible for adding caps, maintaining the machine, and inspecting empty bottles entering the machine. He is also responsible for preparing the machine for operation, which requires 0.5 hour. The labor required for filling 2,400 gallons of milk in glass bottles, which includes preparing the machine for operation, is 7 man-hours. The labor required per 1,000 gallons for bottling 2,400 gallons of milk in glass bottles is 2.92 man-hours and the labor cost is $2.92. The equipment cost based on a 48-quart-per-minute bottle filler and a 20-foot bottle conveyor for 2.70 machine-hours each is $1.53. The total labor and equipment cost is $4.45.

On the basis of bottling 4,800 gallons of milk in paper and glass the labor and equipment requirements per 1,000 gallons are 1.46 man-hours and 2.70 machine-hours. The labor cost is $1.46 and the equipment cost of $0.77. The total labor and equipment cost is $2.23.

Casing glass bottles involves removing the filled bottles from the accumulating table, inverting and inspecting the bottles for cracks or dirt, and placing the bottles in the case. The total time required for casing glass bottles in a plant bottling 2,400 gallons of milk in glass is 6.5 hours. One worker performs the operation. The worker stands at the discharge end of the machine, and the cases are transported to the machine by the same type of conveyor as that employed for paper cases. The total labor required for casing glass bottles is 6.5 man-hours. The labor required per 1,000 gallons for casing 2,400 gallons of milk in glass bottles is 2.71 man-hours and the labor cost is $2.71. The equipment cost based on a 140-foot glass case conveyor for 2.71 machine-hours is 22 cents. The total labor and equipment cost is $2.93.

On the basis of bottling 4,800 gallons of milk in paper and glass the labor and equipment requirements per 1,000 gallons are 1.35 man-hours and 1.35 machine-hours. The labor cost is $1.35 and the equipment cost 11 cents. The total labor and equipment cost is $1.46.

Summary of requirements for bottling milk in paper and glass—The total labor and equipment cost per 1,000 gallons for bottling 4,800 gallons of milk in paper and glass is $18.11 (table 13).

TABLE 13.—*Labor and equipment requirements and costs per 1,000 gallons for bottling 4,800 gallons of milk in paper and glass containers, with a 7-man crew, by operations*

Operation	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Receiving and handling cases	3. 02	[1] 6. 25	3. 02	1. 09	4. 11
Washing bottles	1. 50	[2] 1. 35	1. 50	1. 15	2. 65
Pumping milk to bottling machines	([3])	[4] 2. 67	([3])	. 08	. 08
Filling paper cartons	1. 46	[5] 1. 34	1. 46	4. 70	6. 16
Casing paper cartons	1. 34	[6] 1. 34	1. 34	. 08	1. 42
Filling glass bottles	1. 46	[7] 2. 70	1. 46	. 77	2. 23
Casing glass bottles	1. 35	[8] 1. 35	1. 35	. 11	1. 46
Total	10. 13	17. 00	10. 13	7. 98	18. 11

[1] A 140-foot paper case conveyor and a 140-foot glass case conveyor for a total of 3.33 machine-hours, and two 10-case per minute case washers for a total of 2.92 machine-hours.

[2] A 55-quart per minute bottle washer for 1.35 machine-hours.

[3] No labor required for the operation.

[4] Two 10,000-pound per hour centrifugal pumps for a total of 2.67 machine-hours.

[5] A 45-carton per minute carton machine for 1.34 machine-hours.

[6] A 140-foot paper case conveyor for 1.34 machine-hours.

[7] A 48-quart per minute bottle filler for 1.35 machine-hours, and a 20-foot bottle conveyor for 1.35 machine-hours.

[8] A 140-foot glass case conveyor for 1.35 machine-hours.

BOTTLING MILK IN PAPER

The bottling of milk in paper is based on the bottling of 4,800 gallons of milk by the following quantities and sizes of cartons—15,600 quarts, 2,400 pints, and 9,600 half-pints. The operations involved in bottling milk in paper are: (1) Receiving and handling cases, (2) pumping milk to carton machines, (3) filling paper cartons, and (4) casing paper cartons. An assumed bottling schedule for the purposes of determining labor and equipment requirements for bottling milk in paper is shown in table 14. The bottling schedule is synchronized with the processing schedule for processing at a rate of 7,000 pounds per hour with a balanced system of equipment.

Bottling milk in paper requires a crew of 3 workers, 1 for receiving and handling the cases, 1 for filling cartons, and 1 for casing cartons.

Receiving and handling cases includes transporting cases into case room, washing cases, removing rubbish from cases, stacking and storing cases, loading cases on conveyor, and transporting cases to carton machine. The total time required for receiving and handling cases for a plant bottling 4,800 gallons of milk in paper is 8 hours. One worker is required for receiving and handling cases. The total labor requirements for receiving and handling cases are 8 man-hours. The labor requirements per 1,000 gallons are 1.67 man-hours. The labor cost is $1.67.

TABLE 14.—*An assumed schedule for bottling 4,800 gallons of milk in paper cartons when the product distribution is 3,360 gallons of homogenized milk, 300 gallons of regular milk, 420 gallons of chocolate drink, 60 gallons of skim milk, 60 gallons of cream, and 600 gallons of buttermilk; and the elapsed time for bottling each product*

Product	Bottling in paper cartons [1]		
	Start	Stop	Elapsed time
			Hours
Homogenized milk	8:00 a. m.	12 noon	4. 00
	1:00 p. m.[2]	2:10 p. m.	1. 17
	2:10 p. m.[3]	2:13 p. m.	. 05
Regular milk	2:13 p. m.	2:33 p. m.	. 34
Chocolate drink	2:33 p. m.	3:43 p. m.	1. 16
Cream	3:43 p. m.	3:59 p. m.	. 27
	3:59 p. m.[3]	4:16 p. m.	. 28
Skim milk	4:16 p. m.	4:20 p. m.	. 07
Buttermilk	4:20 p. m.	5:00 p. m.	. 66
Total elapsed time.			8. 00

[1] Based on a 75-carton per minute carton machine with an operating efficiency of 80 percent. The operating efficiency allows for time lost due to machine breakdowns, faulty cartons, and changes of products and carton sizes.

[2] Allowance is made for a 1-hour lunch period.

[3] Wait times necessary to synchronize bottling schedule with processing schedule.

The equipment cost for receiving and handling cases, based on a 140-foot paper case conveyor for 1.67 machine-hours, and a 10-case per minute case washer for 1.04 machine-hours, for a total of 2.71 machine-hours, is 44 cents. The total labor and equipment cost for receiving and handling cases is $2.11 per 1,000 gallons.

Pumping milk to carton machine involves transferring the processed milk from the surge tanks and vats to the carton machine. A 10,000-pound per hour centrifugal pump is required for the transfer of the milk. No labor is involved in the operation. The cost per 1,000 gallons for pumping the milk to the machine, on the basis of the pump for 1.60 machine-hours is 4 cents.

Filling paper cartons includes the same elements as the previously described paper bottling operation. Studies in Georgia dairy plants indicate that carton machines operate at an efficiency of 80 percent. On this basis a 75-carton per minute carton machine fills cartons at a rate of 60 per minute. The total elapsed time required for bottling 4,800 gallons of milk in paper is 8 hours. The elapsed time includes 7.7 hours of bottling time and 0.3 hour of wait time which is necessary to synchronize the bottling and processing schedules. One worker is required for operating the machine. An additional 0.7 hour is required each morning for preparing the machine for operation. The total labor required for filling paper cartons and preparing the machine for bottling 4,800 gallons in paper is 8.7 man-hours. The labor requirements per 1,000 gallons of milk are 1.81 man-hours. The labor cost is $1.81.

The equipment cost per 1,000 gallons of milk for filling paper cartons, based on a 75-carton-per-minute carton machine for 1.60 machine-hours, is $8.30. The total equipment and labor cost for filling paper cartons is $10.11 per 1,000 gallons.

Casing paper cartons involves placing the filled cartons in the empty cases. The operation is the same as that described for the previous method, and one worker is required. The time required for casing paper cartons in bottling 4,800 gallons of milk is 8 hours. The labor requirements are 1.67 man-hours per 1,000 gallons and the labor cost is $1.67. The equipment cost, based on 140-foot paper case conveyor for 1.67 machine-hours is 10 cents per 1,000 gallons of milk. The total labor and equipment cost for casing paper cartons is $1.77 per 1,000 gallons for bottling 4,800 gallons of milk in paper.

Summary of requirements for bottling milk in paper—The total labor and equipment cost per 1,000 gallons for bottling 4,800 gallons of milk in paper is $14.03 (table 15).

Table 15.—*Summary of labor and equipment requirements and costs per 1,000 gallons for bottling 4,800 gallons of milk in paper cartons with a 3-man crew, by operations*

Operation	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Receiving and handling cases	1.67	[1] 2.71	1.67	0.44	2.11
Pumping milk to carton machine	(2)	[3] 1.60	(2)	.04	.04
Filling paper cartons	1.81	[4] 1.60	1.81	8.30	10.11
Casing paper cartons	1.67	[5] 1.67	1.67	.10	1.77
Total	5.15	7.58	5.15	8.88	14.03

[1] A 140-foot paper case conveyor for 1.67 machine-hours and a 10-case per minute case washer for 1.04 machine-hours.

[2] No labor required for the operation.

[3] A 10,000-lb. per hour centrifugal pump for 1.60 machine-hours.

[4] A 75-carton per minute carton machine for 1.60 machine-hours.

[5] A 140-foot paper case conveyor for 1.67 machine-hours.

COMPARISON OF REQUIREMENTS FOR BOTTLING MILK IN PAPER AND GLASS AND IN PAPER

The labor and equipment cost for bottling milk in paper is $4.08 per 1,000 gallons less than the cost for bottling milk in paper and glass. The equipment cost is slightly greater when milk is bottled in paper only, the labor cost, however, is reduced by about 50 percent. The labor cost is reduced by $4.98, whereas the equipment cost is increased by 90 cents. A comparison of the requirements is shown in table 16.

Table 16.—*Labor and equipment requirements and costs per 1,000 gallons for bottling 4,800 gallons of milk in paper and glass containers and in paper cartons only*

Method	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Bottling milk in glass bottles and paper cartons	10.13	[1] 17.00	10.13	7.98	18.11
Bottling milk in paper cartons	5.15	[2] 7.58	5.15	8.88	14.03

[1] A 140-foot paper case conveyor and a 140-foot glass case conveyor, for a total of 6.02 machine-hours, two 10-case per minute case washers for a total of 2.92 machine-hours, a 55-quart per minute bottle washer for 1.35 machine-hours, two 10,000-lb. per hour centrifugal pumps for a total of 2.67 machine-hours, a 45-carton per minute carton machine for 1.34 machine-hours, a 48-quart per minute bottle filler for 1.35 machine-hours, and a 20-foot bottle conveyor for 1.35 machine-hours.

[2] A 140-foot paper case conveyor for 3.34 machine-hours, a 10-case per minute case washer for 1.04 machine-hours, a 10,000-lb. per hour centrifugal pump for 1.60 machine-hours, and a 75-carton per minute carton machine for 1.60 machine-hours.

EQUIPMENT AND METHODS FOR PACKAGING MILK IN CANS

The 5-gallon dispenser can is widely used as a means of distributing milk to schools, restaurants, hospitals, and military installations throughout Georgia. Packaging milk in dispenser cans is relatively new in the State, however, and most plants are inadequately equipped for the performance of can filling operations. At most plants can washing and filling equipment have been fitted in wherever space is available. As a consequence, most can handling operations are inefficiently performed, methods improvement is difficult, if not impossible, and the space available for increasing the volume of milk packaged in cans is limited.

EQUIPMENT USED FOR PACKAGING MILK IN CANS

Can conveyor—The can conveyor is a power-driven conveyor designed especially for cans. It originates at the truck unloading station on the dock, passes through the can washing area and the can filling area, and merges with the case conveyor in the cooler.

Wash vat—A wash vat is a large tub in which cans are placed for manual washing (fig. 26). The vat contains two or three compartments. One compartment is filled with a washing solution, and another with rinse water and possibly a chemical bactericide. A third compartment is often used as a rinse vat for lids.

Can sterilizer—A can sterilizer is a separate unit consisting of a platform equipped with pedal actuated cold water, hot water, and steam jets.

Can washer—The dispenser can washer (fig. 27) consists of a rectangular tank with large brushes at one end, and a raised sterilizing unit at the opposite end. The brushes provide inside and outside scrubbing as the can is revolved in the tank full of washing solution. The sterilizing unit is controlled by foot pedals, and sprays the can with cold water, hot water, or steam.

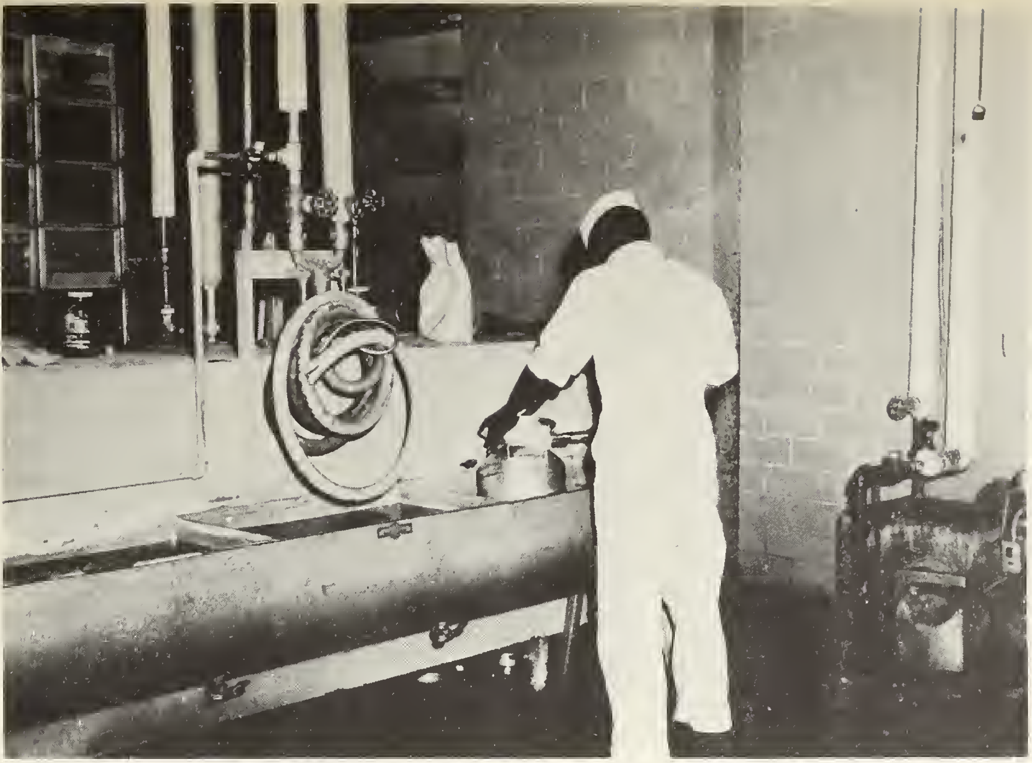


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Figure 26.—A vat in which dispenser cans and lids are washed.

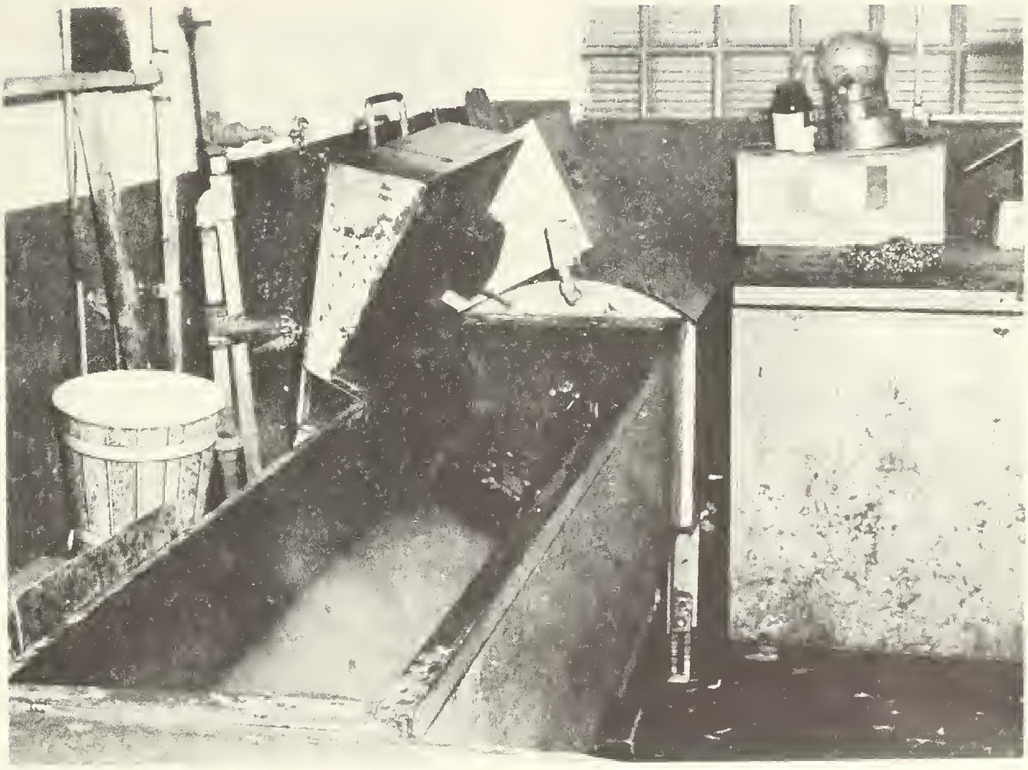

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Figure 27.—Dispenser cans are scrubbed inside and outside by this type of washer.

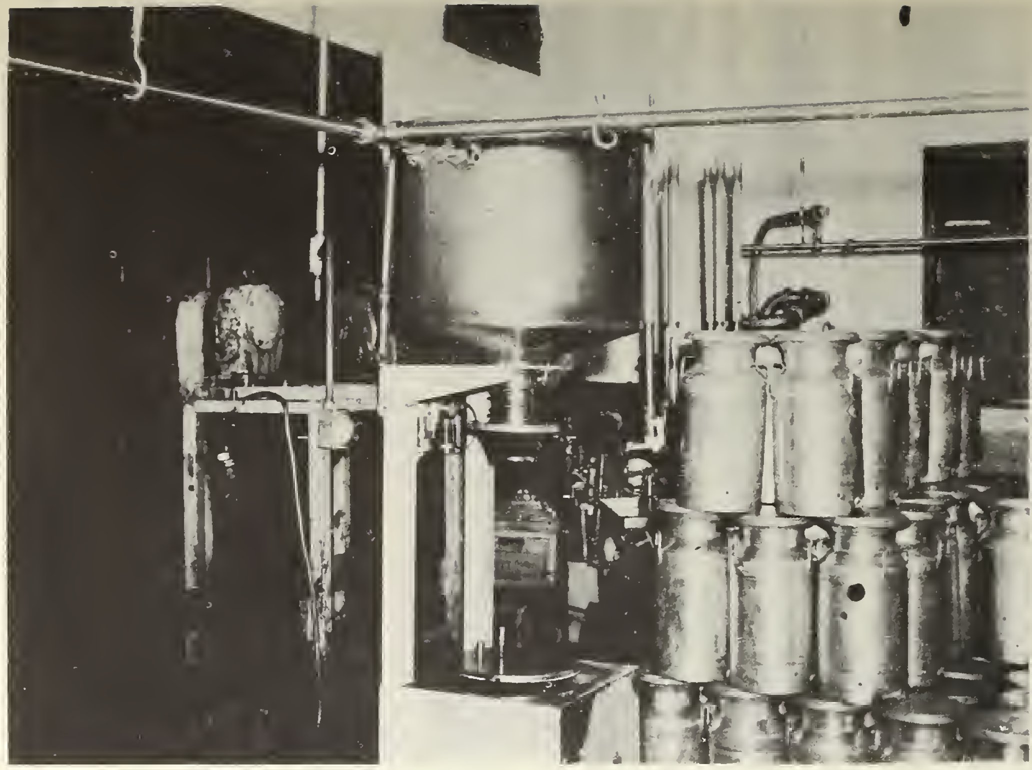

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Figure 28.—Empty cans are placed on the platform and elevated to the filler valve.

Centrifugal pump—A centrifugal pump is used for transferring milk from the surge tank to the can filler. The pump is the same type as those previously described.

Can filling machine—The can filling machine (fig. 28) consists of a filler tank, a vacuum valve, and a hydraulic platform actuated by a foot pedal. As the platform rises, the can forces open the valve, allowing milk to flow into the can.

Filler valve—The filler valve (fig. 29) consists of a manually operated pipe valve attached to a filler tank. The flow of milk from the tank to a can is controlled by opening and closing the filler valve.

METHODS USED FOR PACKAGING MILK IN CANS

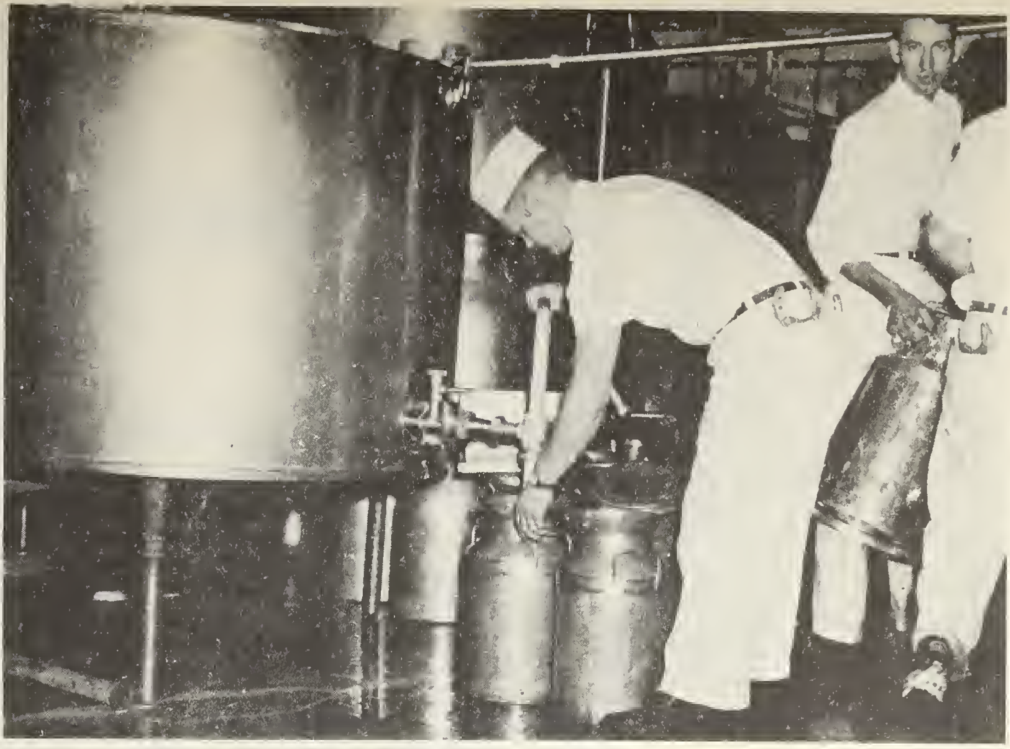
Two methods are used for packaging milk in cans. These methods are the wash vat and filling machine method, and the can washer, conveyor, and filler valve method. The operations performed in packaging milk in cans are the same for both methods. These operations are: (1) Receiving cans, (2) washing cans, (3) sanitizing cans, (4) transporting cans to filler, (5) pumping milk to filler, and (6) filling and sealing cans. For the purposes of comparing labor and equipment requirements for the operations performed, it is assumed that 1,200 gallons of homogenized milk is packaged in 5-gallon dispenser cans.

A crew of three workers is required for performing the operation involved in packaging by both methods. One worker receives, washes, and sanitizes cans: These three operations are performed throughout the day. Two workers transport cans to the filler, fill cans, and seal cans. These operations are performed only for a short period in the afternoon.

PACKAGING MILK IN CANS BY THE WASH VAT AND FILLING MACHINE METHOD

Receiving dispenser cans includes transporting cans into the can room, stacking cans, and storing cans. The only item of equipment involved in the operation is the paper case conveyor. The empty cans are unloaded from trucks onto the case conveyor by the truck drivers. The plant worker removes two cans at a time from the conveyor and stacks them in an assigned storage area.

The receipt of cans is not a continuous operation, but is performed intermittently as the trucks return to the plant. The worker's duties, therefore, must alternate between receiving, washing, and sanitizing cans. On the basis of 1,200 gallons of milk in cans, the total elapsed time required for receiving cans is 0.25 hour. The labor required per 1,000 gallons is 0.21 man-hour and the total cost, based on the labor cost, is 21 cents. The paper case conveyor is not charged to the can receiving oper-



BN–5615

Figure 29.—As the filler pipe is lowered, the milk drains into a can.

ation, because the cost is less than 1 cent per 1,000 gallons.

Washing dispenser cans includes manually placing cans in the wash vat, removing drain hoses, scrubbing cans and lids with a steel pad, rinsing cans and lids, steaming cans, attaching new hoses, replacing lids, and stacking cans. One worker performs the operation. The total elapsed time required for washing cans for 1,200 gallons of milk (240 cans) is 7.5 hours. The labor required per 1,000 gallons is 6.25 man-hours (table 31 of the appendix). The labor cost is $6.25. The equipment cost based on a wash vat for 6.25 machine-hours and a can sterilizer for 0.78 machine-hour, for a total of 7.03 machine-hours is 39 cents per 1,000 gallons. The total labor and equipment cost for washing cans manually is $6.64 per 1,000 gallons.

Sanitizing cans includes removing the clean cans from the rack, removing the lids, rinsing both in a vat filled with a chemical bactericide, replacing the lids, and placing the cans aside. The only item of equipment involved is the wash vat. Sanitizing, according to the health authorities, should be performed immediately before the cans are filled. The total elapsed time required for sanitizing cans for 1,200 gallons of milk is 1.01 hours.

The labor required per 1,000 gallons is 0.84 man-hour, and the labor cost is 84 cents. The equipment cost per 1,000 gallons based on a wash vat for 0.84 machine-hours is 4 cents. The total labor and equipment cost for sanitizing cans is 88 cents.

Transporting cans to filler involves hauling the empty cans from the can-washing room to the filler. Typically, because of insufficient aisle space or floor-level piping, wheeled vehicles cannot be used. The usual practice is based on the manual carrying of cans—two at a time—to the filler. On the basis of a distance of 20 feet, the labor required to transport the cans is 0.42 man-hour per 1,000 gallons. No equipment is involved in the operation. The total cost per 1,000 gallons, based on the labor cost, is 42 cents.

Pumping milk to filler involves pumping the homogenized milk from the surge tank to the can filler. The milk is pumped to the filler tank by a centrifugal pump. No labor is involved in the operation. The cost of the operation, based on a 10,000-pound-per-hour centrifugal pump, for 2.19 machine-hours is 13 cents per 1,000 gallons of milk packaged in cans.

Filling and sealing cans includes: Removing the lids, placing the cans on the filler platform, raising, filling, and lowering the cans, placing the cans on the floor, placing a sheet of parchment paper and a lid on each can, attaching an identification ticket to each can, sealing the cans on two sides with a wire attached to a lead seal, and loading the cans on the case conveyor.

Two workers perform the operation (fig. 30). One worker places the can on the platform, fills the can, places the can on the floor, and places a parchment paper and lid on the can. While one can is being filled, the worker removes the lid from an empty can. The second worker inserts wires through holes on each side of the can and lid, attaches a ticket, and locks the wires by inserting the loose ends through holes in the lead seals and squeezing the seals with a special type of pliers. After the can is sealed, the first worker places it on the case conveyor for transportation to the cooler. The time required by the first worker is 1.44 hours per 1,000 gallons of milk. The elapsed time required by the second worker, who sets the pace of the operation, is 2.19 hours per 1,000 gallons. The total labor required, including 0.75 man-hour of nonproductive time for the first worker, is 4.38 man-hours per 1,000 gallons of milk (table 31 of the appendix). The labor cost is $4.38.

The equipment cost, based on a can filling machine for 0.99 machine-hour, is 49 cents per 1,000 gallons. The total cost of filling and sealing cans by the filling machine method is $4.87 per 1,000 gallons of milk.

Table 17.—*Summary of labor and equipment requirements and costs per 1,000 gallons for packaging 1,200 gallons of milk in 5-gallon dispenser cans by the wash vat and filling machine method, by operations, with a 3-man crew*

Operation	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Receiving cans	0. 21	(1)	0. 21	(1)	0. 21
Washing cans	6. 25	[2] 7. 03	6. 25	. 39	6. 64
Sanitizing cans	. 84	[3] . 84	. 84	. 04	. 88
Transporting cans to filler	. 42	(1)	. 42	(1)	. 42
Pumping milk to filler	(4)	[5] 2. 19	(4)	. 13	. 13
Filling and sealing cans	4. 38	[6] . 99	4. 38	. 49	4. 87
Total	12. 10	11. 05	12. 10	1. 05	13. 15

[1] No equipment required for the operation.

[2] A wash vat for 6.25 machine-hours, and a can sterilizer for 0.78 machine-hour.

[3] A wash vat for 0.84 machine-hour.

[4] No labor required for the operation.

[5] A 10,000-lb.-per-hr. centrifugal pump for 2.19 machine-hours.

[6] A filling machine for 0.99 machine-hour.

A summary of the requirements for packaging milk in cans by the wash vat and filling machine method is given in table 17.

The highest cost operation in packaging cans is the washing can operation. The total cost of this operation is $6.64 per 1,000 gallons. The labor cost is $6.25 and the equipment cost is 39 cents.

The second highest cost operation is the filling and sealing cans operation. The total cost of the operation is $4.87. The labor cost is $4.38 and the equipment cost is 49 cents. The costs incurred in performing the other operations are comparatively minor.

PACKAGING MILK IN CANS BY THE CAN WASHER, CONVEYOR, AND FILLER VALVE METHOD

Receiving cans includes transporting cans into the can room, stacking cans, and storing cans. The only equipment involved is a power can conveyor. The worker who performs the operation also washes and sanitizes cans. The total elapsed time required of the worker for receiving cans for packaging 1,200 gallons of milk in cans is 0.25 hour. The labor required for receiving cans is 0.21 man-hour per 1,000 gallons. The labor cost is 21 cents. The equipment cost for receiving dispenser cans, based on an 87-foot power can conveyor for 4.16 machine-hours, is 87 cents per 1,000 gallon of milk. The total labor and equipment cost per 1,000 gallons is $1.08.

Washing cans with a can washer includes: Removing, washing, and rinsing lids; removing hoses from can; placing cans in washer; scrubbing cans; rinsing and steaming cans; attaching new hoses; replacing lids; and stacking cans. The equipment required for washing cans includes a can washer and a rinse vat. Scrubbing, rinsing, and steaming is done automatically; the other elements are performed manually.

One worker performs the operation, and the total elapsed time required to perform the operation is 6.02 hours. The labor required for washing cans by this method is 5.02 man-hours per 1,000 gallons of milk (table 31 of the appendix). The labor cost is $5.02.

The equipment cost for washing cans per 1,000 gallons of milk, based on a can washer for 2.88 machine-hours and a wash vat for 2.14 machine-hours, for a total of 5.02 machine-hours, is $1.05. The total labor and equipment cost is $6.07.

Sanitizing cans includes the same elements as those previously described. The labor and equipment requirements are also the same, 0.84 man-hour and 0.84 machine-hour. The total cost, based on a labor cost of 84 cents and an equipment cost of 4 cents is 88 cents per 1,000 gallons.

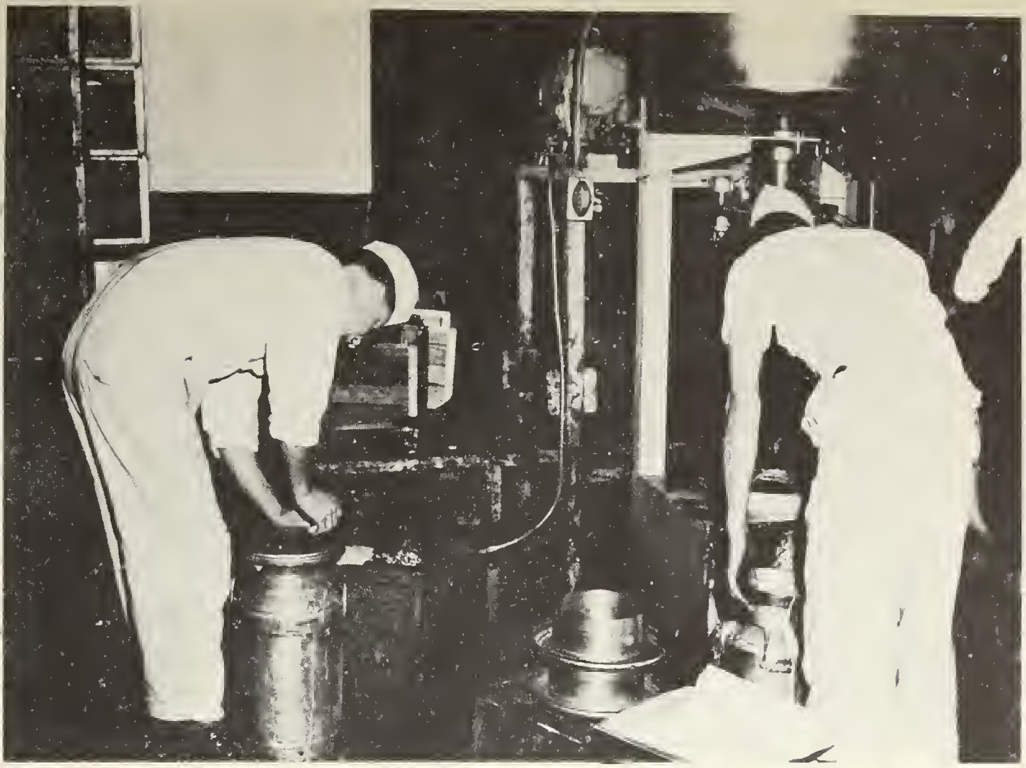


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Figure 30.—Worker on left seals cans while worker on right fills cans.

Transporting cans to filler involves conveying the empty cans from the can washing room to the filler. The only item of equipment involved is the can conveyor. There is no labor involved in the operation. On the basis of an 87-foot can conveyor for 1.38 machine-hours, the total cost of the operation is 10 cents per 1,000 gallons of milk.

Pumping milk to the filler is the same as that previously described. No labor is involved. The cost of the operation, based on a 10,000-pound-per-hour centrifugal pump for 1.38 machine-hours is 12 cents per 1,000 gallons of milk.

Filling and sealing cans, which is performed on the can conveyor, includes: Removing the lid, positioning the can under the filler valve, lowering the tube and filling the can, raising the tube, placing a sheet of parchment paper and a lid on the can, and sealing the can on two sides with a wire and a clasp. The equipment involved in the operation is the filler valve and the can conveyor.

Two workers perform the operation. One worker positions and fills the cans. While one can is being filled, the worker removes a lid from the next can, and places a paper and lid on the previously filled can. The elapsed time required for the worker to fill cans is 1.06 hours per 1,000 gallons. The other worker inserts a wire through the can and lid on one side of the can, and locks the wire with a thin metallic clasp. The process is then repeated on the opposite side of the can. The clasp employed for this method of sealing cans is a thin strip of metal which is bent at a 45° angle to resemble a half-open book. The clasp is easily closed by hand, and teeth prevent its being re-opened. The product and the plant name are printed on the clasp, so an identification ticket is unnecessary. The elapsed time required by the second worker, to seal cans, is 1.38 hours per 1,000 gallons. The second worker sets the pace for the operation; consequently, the total labor required, including 0.32 man-hour of unproductive time for the worker filling cans, is 2.76 man-hours per 1,000 gallons of milk (table 31, appendix). The labor cost is $2.76.

The equipment cost per 1,000 gallons based on a filler valve for 1.07 machine-hours, and an 87-foot can conveyor for 1.38 machine-hours, for a total of 2.45 machine-hours, is 19 cents. The total labor and equipment cost is $2.95.

Summary of requirements for packaging milk in cans by the can washer, conveyor, and filler valve method is shown in table 18.

The washing and the filling and sealing operations account for about 80 percent of the total cost for packaging milk in cans by the can washer, conveyor and filler valve method. The total cost for washing cans is $6.07 and the cost for filling and sealing cans is $2.95.

TABLE 18.—*Summary of labor and equipment requirements and costs per 1,000 gallons for packaging 1,200 gallons of milk in 5-gallon dispenser cans by the can washer, conveyor, and filler valve method, by operations, with a 3-man crew*

Operation	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Receiving cans	0. 21	[1] 4. 16	0. 21	0. 87	1. 08
Washing cans	5. 02	[2] 5. 02	5. 02	1. 05	6. 07
Sanitizing cans	. 84	[3] . 84	. 84	. 04	. 88
Transporting cans to filler	(4)	[5] 1. 38	(4)	. 10	. 10
Pumping milk to filler	(4)	[6] 1. 38	(4)	. 12	. 12
Filling and sealing cans	2. 76	[7] 2. 45	2. 76	. 19	2. 95
Total	8. 83	15. 23	8. 83	2. 37	11. 20

[1] An 87-ft. can conveyor for 4.16 machine-hours.

[2] A can washer for 2.88 machine-hours and a wash vat for 2.14 machine-hours.

[3] A wash vat for 0.84 machine-hour.

[4] No labor required for the operation.

[5] An 87-ft. can conveyor for 1.38 machine-hours.

[6] A 10,000-pound-per-hour centrifugal pump for 1.38 machine-hours.

[7] A filler valve for 1.07 machine-hours and an 87 ft. can conveyor for 1.38 machine-hours.

COMPARISON OF REQUIREMENTS FOR PACKAGING MILK IN CANS BY TWO METHODS

The difference between the cost of packaging milk in cans by the two methods is primarily in the labor cost (table 19). The labor cost is reduced by the use of such items of labor saving equipment as a can washer, a can conveyor, and a filler valve.

TABLE 19.—*Comparison of labor and equipment requirements and costs per 1,000 gallons for packaging 1,200 gallons of milk in 5-gallon dispenser cans by the wash vat and filling machine method and by the can washer, conveyor, and filler valve method*

Method	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Packaging milk in cans by the wash vat and filling machine method	12. 10	[1] 11. 05	12. 10	1. 05	13. 15
Packaging milk in cans by the can washer, conveyor and filler valve method	8. 83	[2] 15. 23	8. 83	2. 37	11. 20

[1] A wash vat for 7.09 machine-hours, a can sterilizer for 0.78 machine-hour, a 10,000-lb.-per-hr. centrifugal pump for 2.19 machine-hours, and a filling machine for 0.99 machine-hour.

[2] An 87-ft. can conveyor for 6.92 machine-hours, a can washer for 2.88 machine-hours, a wash vat for 2.98 machine-hours, a 10,000-lb.-per-hr. centrifugal pump for 1.38 machine-hours, and a filler valve for 1.07 machine-hours.

EQUIPMENT AND METHODS FOR STORING BOTTLED AND PACKAGED MILK

Immediately after milk is packaged and, in the case of cartons and bottles, cased, it is delivered to the cooler. The cases and cans of milk are stacked in the cooler, and stored for a period of one day or less. The cooler is kept at a constant temperature of approximately 35° F. The refrigerated atmosphere maintains the low temperature at which the milk is packaged, but does not serve to cool the milk.

EQUIPMENT USED FOR STORING BOTTLED AND PACKAGED MILK

The major types of equipment used for storing bottled and packaged milk in fluid milk plants in Georgia are described below.

Conveyors—Three conveyors are used for storing bottled and packaged milk. The three conveyors are the two power case conveyors and the power can conveyor, all of which have been described in previous sections.

Case dolly—The case dolly (fig. 31) is a 4-wheel dolly used for transporting and storing cases. The dolly is approximately 5 inches high, 16 inches wide, and 25 inches long, and accommodates two stacks of cases. The dolly consists of an angle iron frame mounted on rubber-tired casters.

Two-wheel case truck—The 2-wheel case truck (fig. 32) is used for transporting stacks of milk cases. The truck has two rubber-tired wheels and a metal or wooden frame. Attached to the front of the frame is an adjustable rack which serves to keep the stack of cases vertical when the frame is tilted backward. The rack is equipped with a hook which raises and supports the bottom case, and flanges which prevent the stack from shifting to the side.

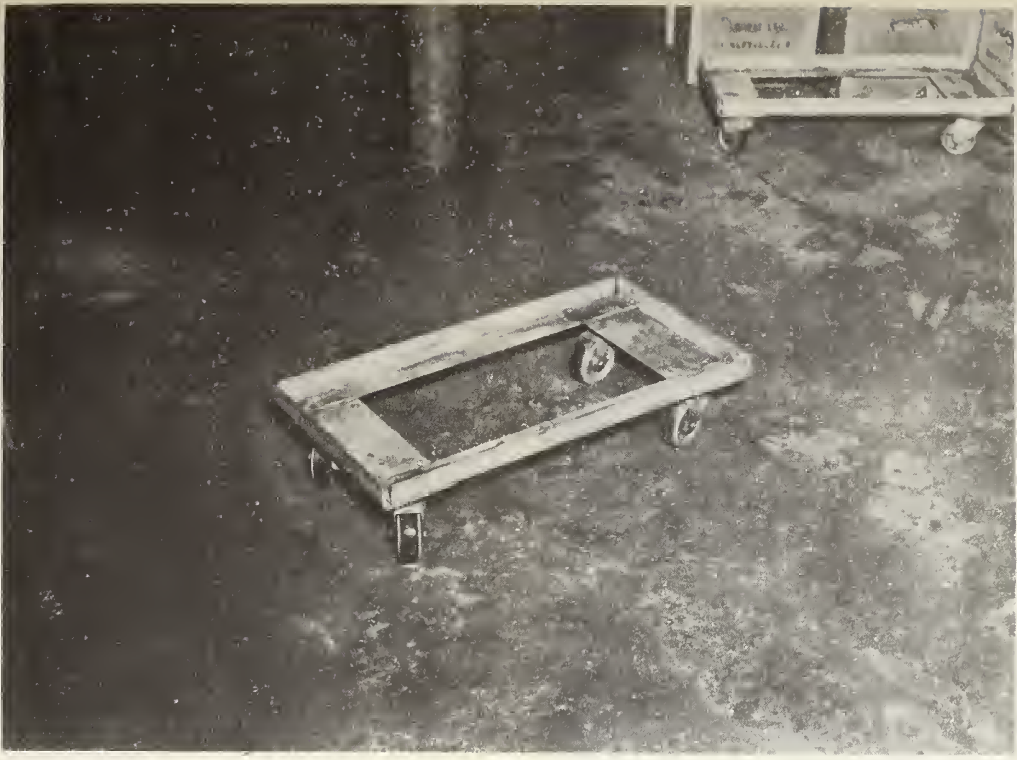

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Figure 31.—Cases are stacked, transported, and stored on case dollies.

METHODS USED FOR STORING BOTTLED AND PACKAGED MILK

Milk is stored in the cooler throughout the bottling and packaging period. The length of this period is determined by the types and sizes of containers used, the bottling and packaging rates, and the volume of milk bottled and packaged.

METHODS USED FOR STORING MILK BOTTLED IN PAPER AND GLASS AND PACKAGED IN CANS

The volume of milk stored daily is 6,000 gallons, 2,400 gallons in paper cartons, 2,400 gallons in glass bottles, and 1,200 gallons in dispenser cans. The elapsed time of the storing period is 6.5 hours, the same as that required for bottling 2,400 gallons in paper and 2,400 gallons in glass.

Two methods are used for storing milk bottled in paper and glass and packaged in cans, the case dolly method, and the 2-wheel case truck method. The operations performed in storing milk by both methods are the same, transporting cases and cans to cooler, and stacking cases and cans.

Storing Milk Bottled in Paper and Glass and Packaged in Cans by the Case Dolly Method

Transporting cases of milk bottled in paper and glass and packaged in dispenser cans to the cooler involves conveying the cases and cans from the filler to the cooler. The equipment required for the operation consists of a 140-foot paper case conveyor, 140-foot glass case conveyor and an 87-foot can conveyor. No labor is involved in the operation.

The equipment cost per 1,000 gallons based on the use of the 140-foot paper case conveyor for 1.07 machine-hours, a 140-foot glass case conveyor for 1.08 machine-hours, and an 87-foot can conveyor for 0.23 machine-hour, for a total of 2.38 machine-hours is 17 cents.

Stacking cases and cans of milk includes removing the cases and cans from the conveyor, transporting them to the storage area, and stacking them.

The number of cases stacked, based on bottling 2,400 gallons in paper and 2,400 gallons in glass in the container sizes shown in table 13 is 1,426. Cases of milk are removed from the conveyor and stacked in two 5-high stacks on a dolly, except in those instances where a few cases of a remaining product are stacked on a separate dolly. The dollies are then pushed to the storage area and left until the following day. The use of 148 case dollies is required for storing the 4,800 gallons of milk. Dispenser cans are manually removed from the conveyor and transported to the storage area. The number of 5-gallon dispenser cans handled in storing 1,200 gallons of milk packaged in cans is 240.

One worker performs the operation. Studies in Georgia indicate that the worker spends 75 percent of his time stacking cans and cases, and 25 per-

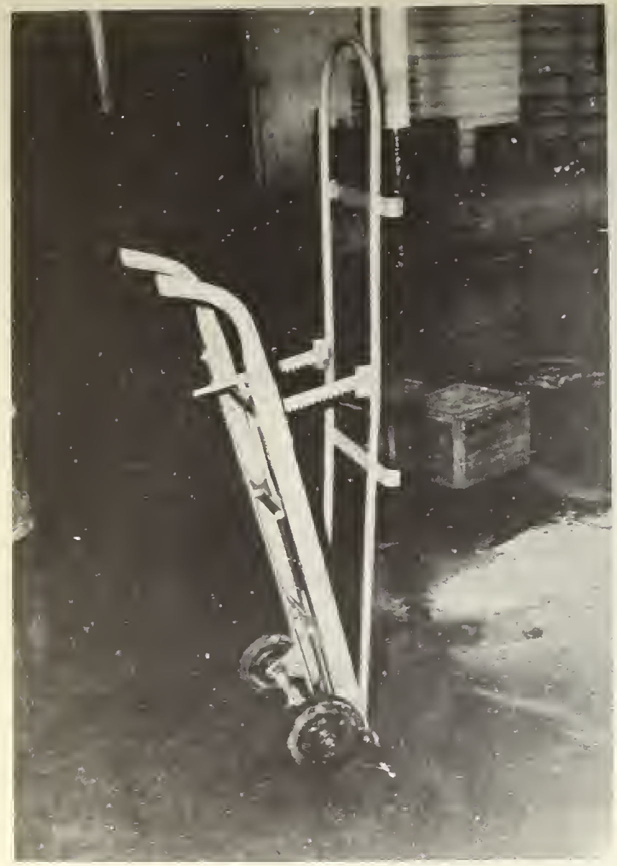

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Figure 32.—Stacks of cases are hauled by 2-wheel case trucks.

cent in waiting. However, the nature of the operation requires the worker to remain in the cooler during the entire storing period. The total elapsed time required for storing 4,800 gallons of milk bottled in glass, and paper and 1,200 gallons packaged in cans is 6.5 hours. The labor required per 1,000 gallons is 1.08 man-hours. The labor cost is $1.08. The equipment cost per 1,000 gallons for storing 6,000 gallons of milk, based on 148 case dollies for a total of 2.15 machine-hours is 28 cents. The total labor and equipment cost is $1.36.

Summary of requirements for storing milk by the case dolly method—The total labor and equipment cost per 1,000 gallons for storing milk bottled in paper and glass and packaged in cans by the case dolly method is $1.53. The labor cost is $1.08 and the equipment cost is 45 cents.

Storing Milk Packaged in Paper and Glass, and Packaged in Cans by the 2-Wheel Case Truck Method

Transporting cases and cans to cooler is the same as described for transporting cases and cans to cooler for the case dolly method. The equipment requirements and cost are also the same, 2.38 machine-hours, and 17 cents per 1,000 gallons. No labor is involved in the operation.

Stacking cases and cans of milk with the use of the 2-wheel case truck includes removing the cases from the conveyor, stacking cases 5-high on the floor, picking the cases up with the case truck, hauling cases to the storage area, dropping the cases in a stacked position, and returning to the conveyor. Cans are removed manually from the conveyor to the storage area. A total of 1,426 cases and 240 5-gallon dispenser cans of milk are stored.

One worker performs the operation. Since the elapsed time is determined by the length of the bottling period, the labor requirements and cost for stacking cases and cans with a 2-wheel case truck are the same as those for stacking cases and cans with case dollies, 1.08 man-hours and $1.08 per 1,000 gallons. The equipment cost per 1,000 gallons, based on a 2-wheel case truck for 0.48 machine-hour is less than 1 cent. The total labor and equipment cost is $1.08.

Summary of requirements for storing milk by the 2-wheel case truck method—The total labor and equipment cost per 1,000 gallons for storing milk bottled in paper and glass and packaged in cans by the 2-wheel case truck method is $1.25. The labor cost is $1.08 and the equipment cost is 17 cents.

METHODS USED FOR STORING MILK BOTTLED IN PAPER AND PACKAGED IN CANS

The volume of milk stored daily is 6,000 gallons, 4,800 gallons bottled in paper, and 1,200 gallons packaged in cans. The elapsed time for the storing period is 8 hours, the same as that required for bottling 4,800 gallons in paper.

Two methods are used for storing milk, the case dolly method and the 2-wheel case truck method. The same operations are performed in storing milk by both methods, transporting cases and cans to cooler, and stacking cases and cans.

Storing Milk Bottled in Paper and Packaged in Cans by the Case Dolly Method

Transporting cases and cans to the cooler involves the same elements as those previously described. No labor is involved in the operation.

The equipment cost based on a 140-foot paper case conveyor for 1.33 machine-hours, and an 87-foot can conveyor for 0.23 machine-hour, for a total of 1.56 machine-hours is 10 cents per 1,000 gallons.

Stacking cases and cans by the dolly method is performed in the same manner as prevoiusly described. The number of cases stacked, on the basis of bottling 4,800 gallons of milk in paper cartons, is 1,032. The number of dollies required for stacking these cases is 104. Cans are manually removed from the conveyor and stacked. A total of 240 5-gallon dispenser cans is handled in stacking the 1,200 gallons of milk packaged in cans.

One worker performs the operation. Studies in Georgia dairy plants indicate that the worker spends 65 percent of his time stacking cases and cans and 35 percent waiting. The nature of the operation requires the worker to remain in the cooler during the entire storing period. The total elapsed time required for storing 4,800 gallons of milk bottled in paper and 1,200 gallons packaged in cans is 8 man-hours. The labor required per 1,000 gallons is 1.33 man-hours, and the labor cost is $1.33.

The equipment cost per 1,000 gallons based on 104 case dollies for a total of 1.33 machine-hours is 19 cents. The total labor and equipment cost is $1.52.

Summary of requirements for storing milk by the case dolly method—The total labor and equipment cost per 1,000 gallons for storing milk bottled in paper and packaged in cans by the case dolly method is $1.62. The labor cost is $1.33, and the equipment cost is 29 cents.

Storing Milk Bottled in Paper and Packaged in Cans by the 2-Wheel Case Truck Method

Transporting cases and cans to cooler is the same operation as previously described. The equipment requirements and costs are also the same, 1.56 machine-hours and 10 cents per 1,000 gallons. No labor is required for the operation.

Stacking cases and cans was previously described for the 2-wheel case truck method. A total of 1,032 cases of milk and 240 5-gallon dispenser cans of milk are stacked.

One worker performs the operation. The labor requirements and costs are the same as for stacking cases by the dolly method, 1.33 man-hours and $1.33 per 1,000 gallons. The equipment cost, based on a 2-wheel case truck for 0.34 machine-hour, is less than 1 cent per 1,000 gallons. The total labor and equipment cost is $1.33.

Summary of requirements for storing milk by the 2-wheel case truck method—The total labor and equipment requirements for storing milk bottled in paper and packaged in cans by the 2-wheel case truck method is $1.43. The labor cost is $1.33 and the equipment cost is 10 cents.

The total cost for the case dolly method of storing milk bottled in paper and packaged in cans is $1.62 per 1,000 gallons. This cost is based on a labor cost of $1.33 and an equipment cost of 29 cents. The total cost for storing milk by the 2-wheel case truck method is $1.43 per 1,000 gallons and is based on a labor cost of $1.33 and an equipment cost of 10 cents. Storing milk by the 2-wheel case truck method reduces the cost by 19 cents per 1,000 gallons.

COMPARISON OF METHODS USED FOR STORING MILK

The total cost for storing milk bottled in paper and glass and packaged in cans by the case dolly method is $1.53 per 1,000 gallons as compared with $1.25 for storing milk by the 2-wheel case truck method (table 20). The reduction in the cost for storing by the 2-wheel case truck method of 28 cents per 1,000 gallons is the result of a reduced equipment cost. The equipment cost for

Table 20.—*Comparison of labor and equipment requirements and costs per 1,000 gallons for storing 6,000 gallons of milk bottled in paper and glass and packaged in cans, and bottled in paper and packaged in cans, by methods, with a 1-man crew*

Method	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
Storing milk bottled in paper and glass and packaged in cans by:[1]	*Man-hours*	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
The case dolly method	1.08	[2] 4.53	1.08	0.45	1.53
The 2-wheel case truck method	1.08	[3] 2.86	1.08	.17	1.25
Storing milk bottled in paper and packaged in cans by:[4]					
The case dolly method	1.33	[5] 2.89	1.33	.29	1.62
The 2-wheel case truck method	1.33	[6] 1.90	1.33	.10	1.43

[1] Forty percent of the volume bottled in paper, 40 percent in glass, and 20 percent packaged in cans.

[2] A 140-ft. paper case conveyor for 1.07 machine-hours, a 140-ft. glass case conveyor for 1.08 machine-hours, an 87-ft. can conveyor for 0.23 machine-hour, and 148 case dollies for 2.15 machine-hours.

[3] A 140-ft. paper case conveyor for 1.07 machine-hours, a 140-ft. glass case conveyor for 1.08 machine-hours, an 87-ft. can conveyor for 0.23 machine-hour, and a 2-wheel case truck for 0.48 machine-hour.

[4] Eighty percent of the volume bottled in paper and 20 percent packaged in cans.

[5] A 140-ft. paper case conveyor for 1.33 machine-hours, an 87-ft. can conveyor for 0.23 machine-hour, and 104 case dollies for 1.33 machine-hours.

[6] A 140-ft. paper case conveyor for 1.33 machine-hours, an 87-ft. can conveyor for 0.23 machine-hour, and a 2-wheel case truck for 0.34 machine-hour.

storing milk with the case dolly method is 45 cents per 1,000 gallons as compared to 17 cents with the 2-wheel case truck method.

The total cost for storing milk bottled in paper and packaged in cans by the case dolly method is $1.62 per 1,000 gallons as compared with $1.43 for the 2-wheel case truck method. All of the reduction in cost, 19 cents per 1,000 gallons, is based on the lower equipment cost associated with the use of a 2-wheel case truck.

The cost for storing milk by the case dolly method is 9 cents per 1,000 gallons less when milk is bottled in paper and glass and packaged in cans. Although the equipment cost is greater when milk is bottled in paper and glass, and packaged in cans, the labor cost, based on a shorter bottling and storing period, reduces the total cost of storing.

The cost for storing milk by the 2-wheel case truck method is 18 cents per 1,000 gallons less when milk is bottled in paper and glass and packaged in cans. Although the equipment cost is greater when milk is bottled in paper and glass, and packaged in cans, the labor cost, based on a shorter bottling and storing period, reduces the total cost of storing.

EQUIPMENT AND METHODS FOR LOADING OUT MILK

Milk is loaded into delivery trucks each morning for wholesale and retail distribution. Loading out is usually begun between the hours of 3 a. m. and 6 a. m. The hours vary widely among plants. Plant labor, which does not include truckdrivers, is responsible for loading cases and cans on the conveyor for transporting to the dock. The truckdrivers put ice in the cases, unload the conveyor, and load the trucks. The outgoing conveyor is split to form a "Y" on the loading dock, allowing the drivers to switch the flow of cases and cans from one truck to another. Thus, loading is continuous, and no time is lost between trucks.

EQUIPMENT USED FOR LOADING OUT MILK

The equipment used for loading out milk is essentially the same for all plants.

Conveyor—One conveyor, a power case conveyor which has been previously described is used for loading out. As the conveyor emerges from the cooler it forms a "Y", one section of the "Y" being a gravity conveyor.

Case dolly—The case dollies are the same as those described in the previous section.

Two-wheel case truck—The 2-wheel case truck is the same as that described in the previous section.

METHODS USED FOR LOADING OUT MILK

METHODS USED FOR LOADING OUT MILK BOTTLED IN PAPER AND GLASS AND PACKAGED IN CANS

The volume of milk loaded out is 6,000 gallons, 2,400 gallons bottled in paper, 2,400 gallons bottled in glass, and 1,200 gallons packaged in cans. The number of cases of paper-bottled milk is 516 and the number of cases of glass-bottled milk is 910. The number of 5-gallon dispenser cans filled is 240.

Two methods are used for loading out milk botttled in paper and glass and packaged in cans, the case dolly method and the 2-wheel case truck method. The operations performed in loading out milk by both methods are the same, loading conveyor, and transporting cases and cans to dock.

Loading Out Milk Bottled in Paper and Glass and Packaged in Cans by the Case Dolly Method

Loading conveyor includes transporting cans and stacks of cases from the storage areas to the conveyor, and placing them on the paper conveyor. In loading out cases, dollies stacked 5-high with cases are pushed to the paper conveyor and the cases are manually loaded onto the conveyor. Cans are manually carried from storage and loaded on to the conveyor. One worker loads out cases and cans. Using an order ticket as a guide, the worker selects the items ordered for each truck and loads them on the conveyor.

The time required for loading cases and cans onto the paper conveyor by this method is 0.34 hour per 1,000 gallons based on a transport distance of 10 feet for cases and 4 feet for cans (table 32, appendix). Truck drivers move cases and cans from the conveyor onto the trucks. The time required for loading trucks is 0.60 hour per 1,000 gallons. The labor used for loading trucks is not charged to the operation. Since loading trucks paces the operation the labor requirements for loading cases and cans onto the conveyor are based on the truck loading time. Therefore the labor requirement for the operations is 0.60 man-hour per 1,000 gallons. The equipment cost per 1,000 gallons, based on 148 dollies for 0.60 machine-hour is 28 cents. The total cost for loading the conveyor by the dolly method is 88 cents.

Transporting cases and cans to dock involves conveying the milk from the loading position to the truck loading position on the dock. No labor is involved in the operation. The total cost, based on a 140-foot paper case conveyor for 0.60 machine-hour is 12 cents per 1,000 gallons.

Summary of requirements for loading out milk by the case dolly method—The total cost per 1,000 gallons for loading out milk bottled in paper and glass and packaged in cans by the case dolly method with a 1-man crew is $1. The labor cost is 60 cents and the equipment cost is 40 cents.

Loading Out Milk Bottled in Paper and Glass and Packaged in Cans by the 2-Wheel Case Truck Method

Loading conveyor—In loading cases of milk onto the paper conveyor with a 2-wheel case truck, the worker picks up stacks of cases with the case truck, transports the stack to the conveyor aisle, places the stacks on the floor, and loads the cases on the conveyor. Cans are loaded manually. One worker performs the operation and the elapsed time required for it is 0.73 hour per 1,000 gallons based on transport distance of 10 feet for cases and 4 feet for cans (table 33, appendix). The labor required for the operation is 0.73 man-hour and the labor cost is 73 cents. Since the truck loading time is 0.60 hour per 1,000 gallons, the time for loading trucks is increased about 22 percent.

The equipment cost based on a 2-wheel case truck for 0.48 machine-hour is less than 1 cent per 1,000 gallons. Thus, the total cost for loading the conveyor by the 2-wheel case truck method is 73 cents per 1,000 gallons.

Transporting cases and cans to dock—This operation is the same as that previously described. The equipment cost, based on a 140-foot paper case conveyor for 0.73 machine-hour, is 12 cents per 1,000 gallons. No labor is involved in the operation.

Summary of requirements for loading out milk by the 2-wheel case truck method—The total cost per 1,000 gallons for loading out milk bottled in paper and glass, and packaged in cans by the 2-wheel case truck method with a 1-man crew is 85 cents per 1,000 gallons. The labor cost is 73 cents and the equipment cost is 12 cents.

METHODS USED FOR LOADING OUT MILK BOTTLED IN PAPER AND PACKAGED IN CANS

The volume of milk loaded out is 6,000 gallons, 4,800 gallons bottled in paper and 1,200 gallons packaged in cans. The number of cases of paper bottled milk is 1,032. The number of 5-gallon dispenser cans filled is 240.

Cases and cans of milk are loaded out by two methods, the case dolly method and the 2-wheel case truck method. The operations performed in loading out milk by both methods are the same, loading conveyor and transporting cases and cans to dock.

Loading Out Milk Bottled in Paper and Packaged in Cans by the Case Dolly Method

Loading conveyor involves the same elements as those previously described for loading the conveyor by dolly. One worker performs the operation. The time required for loading cases and cans onto the conveyor is 0.25 hour per 1,000 gallons based on transporting cases 10 feet and cans 4 feet (table 32, appendix). The loading of trucks sets the pace for loading cases and cans of milk onto the paper conveyor. Since the elapsed time for loading the trucks is 0.44 hour, therefore, the labor required for loading the conveyor is 0.44 man-hour per 1,000 gallons, and the labor cost is 44 cents. The equipment cost per 1,000 gallons, based on 104 dollies for 0.44 machine-hour, is 19 cents per 1,000 gallons. The total labor and equipment cost is 63 cents.

Transporting cases and cans to dock includes the same elements as those previously described. No labor is involved in the operation. The equipment cost per 1,000 gallons, based on a 140-foot paper conveyor for 0.44 machine-hour, is 10 cents.

Summary of requirements for loading out milk by the case dolly method—The total cost per 1,000 gallons for loading out milk bottled in paper and packaged in cans by the case dolly method with a 1-man crew is 73 cents. The labor cost is 44 cents and the equipment cost is 29 cents.

Loading Out Milk Bottled in Paper and Packaged in Cans by the 2-Wheel Case Truck Method

Loading conveyor involves the same elements as those previously described for loading the conveyor by the 2-wheel case truck method. The elapsed time for the operation is 0.54 hour per 1,000 gallons, based on a transport distance of 10 feet for cases and 4 feet for cans (table 33, appendix). One worker performs the operation; thus the labor requirements are 0.54 man-hour and the cost is 54 cents. Since loading the truck requires only 0.44 hour per 1,000 gallons the truck loading time is increased by about 23 percent.

The equipment cost, based on a 2-wheel case truck for 0.34 machine-hour, is less than 1 cent per 1,000 gallons. The total cost for the operation, based only on the cost of labor, is 54 cents per 1,000 gallons.

Transporting cases and cans to dock includes the same elements as those previously described. No labor is involved in the operation. The equipment cost per 1,000 gallons, based on a 140-foot paper case conveyor for 0.54 machine-hour, is 10 cents per 1,000 gallons.

Summary of requirements for loading out milk by the 2-wheel case truck method—The total cost per 1,000 gallons for loading out milk bottled in paper and packaged in cans by the 2-wheel case truck method is 64 cents. The labor cost is 54 cents and the equipment cost is 10 cents.

COMPARISON OF METHODS USED FOR LOADING OUT MILK

The cost for loading out milk bottled in paper and glass and packaged in cans is 15 cents per 1,000 gallons less when the 2-wheel case truck method is used, as opposed to the case dolly method. Costs are reduced 9 cents per 1,000 gallons for loading out milk bottled in paper and packaged in cans with the 2-wheel case truck method (table 21). The reduction in cost for loading out milk with the 2-wheel case truck method is in the cost of equipment. Labor costs are higher when milk is loaded out by the 2-wheel case truck method.

Loading out milk bottled in paper and glass, and packaged in cans, and milk bottled in paper and packaged in cans by the 2-wheel case truck method requires a greater elapsed time than that required for loading out by the case dolly method. Consequently, the truck loading time would be increased by approximately 22 percent when the 2-wheel case truck method is used.

For both the case dolly method and the 2-wheel case truck method the cost of loading out is lower for milk bottled in paper and packaged in cans than for milk bottled in paper and glass and packaged in cans. For a given volume of milk, fewer cases are required for paper cartons than for glass bottles. The labor costs are lower, therefore, because there are fewer cases to be handled when milk is bottled only in paper. The equipment costs are lower primarily because a fewer number of dollies is required.

Table 21.—*Comparison of labor and equipment requirements and cost per 1,000 gallons for loading out 6,000 gallons of milk bottled in paper and glass and packaged in cans, and bottled in paper and packaged in cans, by methods, with a 1-man crew*

Method	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
Loading out milk bottled in paper, glass, and packaged in cans: [1]	*Man-hours*	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
Case dolly method	0.60	[2] 1.20	0.60	0.40	1.00
Two-wheel case truck method	.73	[3] 1.21	.73	.12	.85
Loading out milk bottled in paper, and packaged in cans: [4]					
Case dolly method	.44	[5] .88	.44	.29	.73
Two-wheel case truck method	.54	[6] .88	.54	.10	.64

[1] Forty percent of the volume bottled in paper 40 percent in glass, and 20 percent packaged in cans.

[2] A 140-ft. paper case conveyor for 0.60 machine-hour, and 148 case dollies for 0.60 machine-hour.

[3] A 140-ft. paper case conveyor for 0.73 machine-hour, and a 2-wheel case truck for 0.48 machine-hour.

[4] Eighty percent of the volume bottled in paper and 20 percent packaged in cans.

[5] A 140-ft. paper case conveyor for 0.44 machine-hour, and 104 case dollies for 0.44 machine-hour.

[6] A 140-ft. paper case conveyor for 0.54 machine-hour, and a 2-wheel case truck for 0.34 machine hour.

EQUIPMENT AND METHODS FOR CLEANING MILK-HANDLING EQUIPMENT

At the end of each work day all milk-handling equipment must be treated for the removal of milk film and bacteria. In addition to cleaning all milk contact surfaces, it is also necessary to clean the non-milk contact surfaces of the equipment. Thus, both the interior and exterior surfaces of the equipment must be effectively cleaned. Cleaning is an important function in fluid milk plants, and the cleaning standards are determined and enforced by the local city and county health departments. Cleaning standards are usually based on the recommendations of the U. S. Public Health Service.

This analysis of cleaning operations pertains only to those items of equipment cleaned by the regular cleaning crew. It does not apply to the labor required for cleaning items of equipment during the work day by the processing or bottling workers.

EQUIPMENT USED FOR CLEANING MILK-HANDLING EQUIPMENT

The major items of equipment most commonly used for cleaning milk-handling equipment in fluid milk plants are described below.

Cleaned-in-place pipe—Cleaned-in-place, C. I. P., pipe is a system of permanent, continuous pipe through which various cleaning solutions are circulated upon completion of the milk-handling operations. For the purpose of this report,

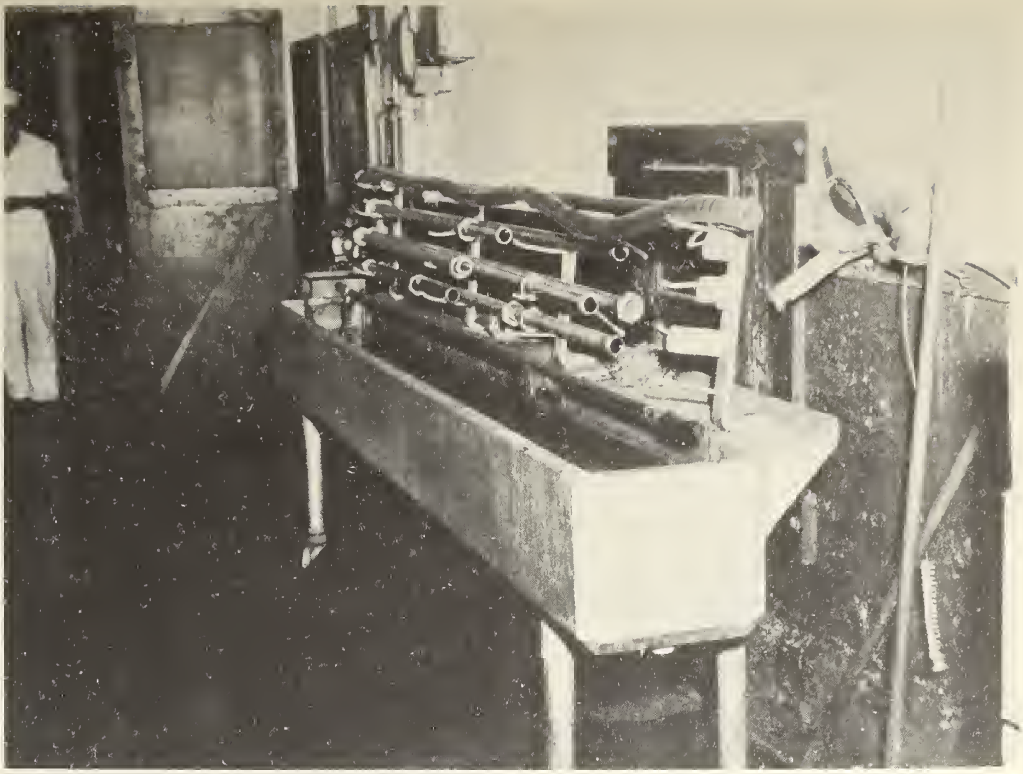

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Figure 33.—A pipe-washing vat equipped with a pipe-washing brush and a pipe rack.

C. I. P. pipe is stainless steel pipe with a 1½-inch inside diameter.

C. I. P. tank and pump—A 100-gallon tank and a centrifugal pump are employed for C. I. P. cleaning. The various cleaning solutions are prepared in the tank, and then pumped directly through the pipe circuit.

Pipe washer—The pipe washer (fig. 33) consists of a wash vat, a pipe-washing brush, and a pipe rack. The vat should be approximately 11 feet long, 2 feet wide, and 1 foot deep. Along the top of the vat is a pipe-washing brush, usually revolving, attached to a hollow pipe 10 to 12 feet in length, through which a soap solution is piped. A storage rack for clean pipe is attached to the back of the vat.

METHODS USED FOR CLEANING MILK-HANDLING EQUIPMENT

The labor and equipment required for cleaning milk-handling equipment in fluid milk plants are largely dependent upon the types and sizes of equipment used, the types of products prepared, and the arrangement of the equipment. For the purposes of this analysis, the methods of cleaning milk-handling equipment are discussed on the basis of cleaning milk-handling equipment in a plant that receives milk in cans and bottles milk in paper and glass, and a plant that receives milk in bulk and bottles milk in paper. The volume handled and the products processed are the same as those previously described. The labor requirements for each type of plant are based on proper arrangements of equipment and well engineered systems of piping. Thus, all equipment is readily accessible for cleaning, and the footage of pipe is held to a minimum.

Many items of equipment are common to both types of plant, and the labor and equipment requirements for cleaning most of these items are not affected by the type of plant. Table 22 shows the labor and equipment requirements for cleaning specific items of equipment used in receiving, processing, bottling, and packaging milk. The cleaning operations are usually begun immediately after the processing and bottling operations are completed. As a rule there is no particular sequence or schedule for cleaning operations, and the workers follow their own routine. Most cleaning crews consist of two workers. The crew sizes vary, however, because it is the policy at many plants for the receiving, processing, or bottling workers to clean the equipment within their own departments. For the purpose of this analysis, all evening cleanup work is done by a two-man cleaning crew.

TABLE 22.—*Labor and equipment requirements and costs per 1,000 gallons for cleaning specific items of milk-handling equipment used for receiving, processing, and bottling milk, and packaging milk in cans, for a 6,000-gallon-per-day plant*

Item of equipment	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
500-lb. weigh tank	0.04	0	0.04	0	0.04
1,000-lb. receiving vat	.03	0	.03	0	.03
4,000-gal. storage tank	.05	0	.05	0	.05
300-gal. surge tank	.05	0	.05	0	.05
500-gal. chocolate tank	.04	0	.04	0	.04
800-gal. skim milk tank	.08	0	.08	0	.08
100-gal. cream vat	.05	0	.05	0	.05
25,000-lb.-per-hr. plate cooler	.01	0	.01	0	.01
12,000-lb.-per.-hr. standardizing clarifier	.17	0	.17	0	.17
8,000-lb.-per-hr. pasteurizer	.02	0	.02	0	.02
8,600-lb.-per-hr. homogenizer	.11	0	.11	0	.11
5,500-lb.-per-hr. separator	.17	0	.17	0	.17
45-carton-per-min. carton machine	.15	0	.15	0	.15
75-carton-per-min. carton machine	.28	0	.28	0	.28
48-qt.-per-min. bottle filler	.15	0	.15	0	.15
Can filler valve and tank	.03	0	.03	0	.03
Four 5,500 to 60,000-lb.-per-hr. pos.-displ. pumps	.16	0	.16	0	.16
Four 10,000-lb.-per-hr. centrifugal pumps	.12	0	.12	0	.12
366 linear feet-1½-in. I. D. cleaned-in-place pipe plus fittings	.54	[1] 2.05	.54	.10	.64
359 linear feet-1½-in. I. D. take-down pipe plus fittings	.51	[2] 0.09	.51	.03	.54

[1] A C. I. P. tank for 0.67 machine-hour and 2 10,000-lb.-per-hr. centrifugal pumps for 0.67 machine-hour each, and a pipe washer for 0.04 machine-hour.

[2] A pipe washer for 0.09 machine-hour.

METHODS USED FOR CLEANING MILK-HANDLING EQUIPMENT IN PLANTS RECEIVING MILK IN CANS AND BOTTLING MILK IN PAPER AND GLASS

Two methods are used for cleaning milk-handling equipment in plants receiving milk in cans and bottling milk in paper and glass. These methods are the cleaned-in-place pipe method and the take-down pipe method.

Cleaning Equipment in Plants Receiving Milk in Cans and Bottling Milk in Paper and Glass by the Cleaned-in-Place Pipe Method

The items of equipment cleaned by the cleaned-in-place pipe method in a plant receiving milk in cans and bottling milk in paper and glass are: 366 feet of C. I. P. pipe, a 500-pound weigh tank, a 1,000 pound receiving vat, a 4,000-gallon storage tank, a 300-gallon surge tank, a 500-gallon chocolate tank, an 800-gallon skim milk tank, a 100-gallon cream vat, a 25,000-pound-per-hour plate cooler, a 12,000-pound-per-hour standardizing clarifier, an 8,000-pound-per-hour pasteurizer, an 8,600-pound-per-hour homogenizer, a 5,500 pound-per-hour separator, four 5,500- to 60,000-pound-per-hour positive-displacement pumps, four 10,000-pound-per-hour centrifugal pumps, a 45-carton-per-minute carton machine, a 48-quart-per-minute bottle filler, and a can filler valve.

Cleaning pipe—The piping system in the receiving and processing area consists of approximately 366 linear feet of 1½-inch I. D. stainless steel C. I. P. pipe. Two circuits are employed for cleaning purposes; one circuit is circulated from the C. I. P. tank, and one circuit is circulated from the pasteurizer balance tank. Most of the pipe is cleaned in place by the circulation of various cleaning solutions. Approximately 10 percent of the pipe must be removed, however, for manual cleaning. Cleaning C. I. P. pipe involves: Connecting C. I. P. pumps; inserting temperature recording charts in system, as required by the health departments; removing storage tank fittings; removing take-down pipes and making necessary by-passes; checking lines, rinsing circuits with cold water; rinsing circuits with hot water; preparing acid cleaner; circulating and then draining acid cleaner; preparing washing solution; circulating and then draining washing solution; flushing circuit with water; preparing bactericide; circulating and then draining bactericide; opening pasteurizer plates for drainage; removing, cleaning, and replacing 3-way valves; cleaning and replacing take-down pipe and storage tank fittings; closing pasteurizer plates; and disconnecting C. I. P. pumps.

The labor requirements for cleaning C. I. P. piping are determined on the basis of the actual man-hours required for setting up, operating, and dismantling the C. I. P. equipment. During the time that the various solutions are circulating through the pipe, the workers clean other items of equipment, and the labor is charged to the other operations rather than to the pipe cleaning. The labor required for cleaning C. I. P. pipe is 0.54 man-hour per 1,000 gallons, and the labor cost per 1,000 gallons is 54 cents. The equipment cost based on a C. I. P. tank for 0.67 machine-hour, two 10,000-pound-per-hour centrifugal pumps for 0.67 machine-hour each, and a pipe washer for 0.04 machine-hour, for a total of 2.05 machine-hours, is 10 cents per 1,000 gallons.

The total labor and equipment cost for cleaning C. I. P. pipe is 64 cents per 1,000 gallons.

Cleaning tanks involves: Removing all removable fixtures; rinsing tanks with water; preparing washing solution; climbing into tanks; scrubbing inside of tanks with a pad or brush (fig. 34); climbing out of tanks; scrubbing outside of tanks, excluding any painted surfaces; scrubbing fixtures; rinsing fixtures and tanks; replacing fixtures; and steaming tanks. The labor requirements for cleaning tanks vary with the size and function of the tank. The total labor required for cleaning the 7 tanks listed for the C. I. P. pipe method is 0.34 man-hour per 1,000 gallons. The labor cost is 34 cents.

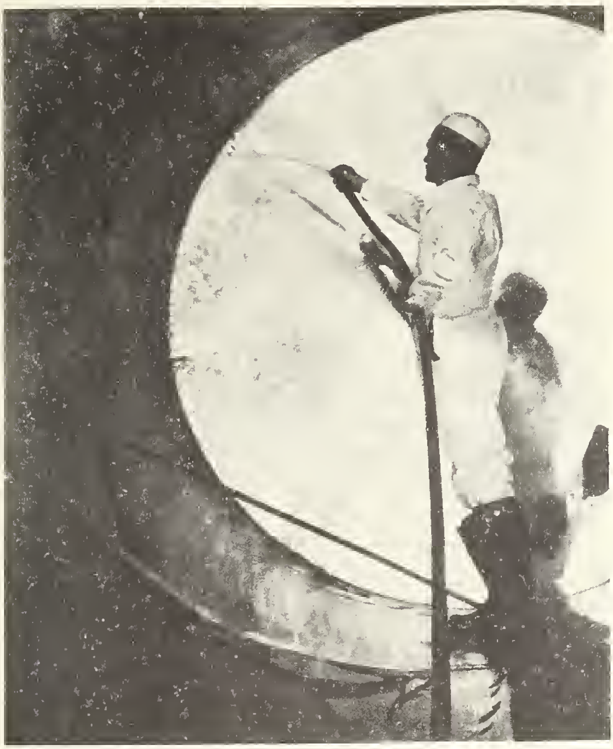

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Figure 34.—A worker cleaning the inside of a milk storage tank.

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Cleaning the plate cooler involves the circulation of cleaning solutions and water through the cooler. The labor required for cleaning a 25,000-pound-per-hour plate cooler is 0.01 man-hour per 1,000 gallons and the labor cost is 1 cent.

Cleaning the standardizing clarifier involves removing all removable milk-contact surfaces, scrubbing all surfaces with a washing solution and a scrub brush or steel pad, rinsing all surfaces, steaming all surfaces, and reassembling machine. The labor required for cleaning a 12,000-pound-per-hour standardizing clarifier is 0.17 man-hour per 1,000 gallons, and the labor cost is 17 cents.

Cleaning the pasteurizer involves circulating cleaning solutions through the machine. Once a week the pasteurizer plates are spread apart, scrubbed with a hand brush, rinsed and reassembled. The labor required for cleaning an 8,000-pound-per-hour pasteurizer is 0.02 man-hour per 1,000 gallons, and the labor cost is 2 cents.

The method employed in **cleaning a homogenizer** is the same as that employed in cleaning a standardizing clarifier. The labor requirements per 1,000 gallons for cleaning an 8,600-pound-per-hour homogenizer is 0.11 man-hour, and the labor cost is 11 cents.

The separator is cleaned in the same manner as the standardizing clarifier. The labor required for cleaning a 5,500-pound-per-hour separator is 0.17 man-hour per 1,000 gallons, and the labor cost is 17 cents.

Cleaning positive displacement pumps involves the same elements as cleaning the standardizing clarifier. Four pumps are cleaned, and the labor requirements are the same for each of the pumps. The total labor required for cleaning four positive displacement pumps is 0.16 man-hour per 1,000 gallons, and the labor cost is 16 cents.

The method used in **cleaning centrifugal pumps** is the same as that used in cleaning a standardized clarifier. The labor required for cleaning four 10,000-pound-per-hour centrifugal pumps is 0.12 man-hour per 1,000 gallons, and the labor cost is 12 cents.

Cleaning the carton machine involves removing all removable milk-contact parts, rinsing machine and parts, scrubbing machine and parts, rerinsing machine and parts, steaming machine and parts, greasing moving parts, and reassembling machine. The labor required for cleaning a 45-carton-per-minute carton machine is 0.15 man-hour per 1,000 gallons, and the cost is 15 cents.

Cleaning the bottle filler and capper involves the same elements as those involved in cleaning the carton machine. The labor required for cleaning a 48-quart-per-minute bottle filler and capper is 0.15 man-hour per 1,000 gallons, and the labor cost is 15 cents.

Cleaning the can filler valve and tank involves disassembling the valve; rinsing, scrubbing, rerinsing, and steaming the valve and tank; and reassembling the valve. The labor required for cleaning the assembly is 0.03 man-hour, and the labor cost is 3 cents.

Summary of requirements for cleaning milk-handling equipment by the cleaned-in-place pipe method—The total cost for cleaning milk-handling equipment by the C. I. P. pipe method is $2.07 per 1,000 gallons. The labor cost is $1.97 and the equipment cost is 10 cents. All of the equipment cost is charged to the pipe-cleaning operation. The pipe-cleaning operation also incurs a greater labor cost than any other operation. The labor cost for the operation is 54 cents.

Cleaning Equipment in Plants Receiving Milk in Cans and Bottling Milk in Paper and Glass by the Take-Down Pipe Method

Cleaning take-down pipe involves disconnecting all pipe, hauling pipe to the pipe washer, scrubbing and rinsing pipe, storing pipe until all other items of equipment have been cleaned, returning pipe to its original position, and reassembling pipe. The entire operation is performed manually. The labor required for cleaning 359 linear feet of pipe plus fittings is 0.51 man-hour per 1,000 gallons, and the labor cost is 51 cents. The equipment cost, based on a pipe washer for 0.09 machine-hour, is 3 cents per 1,000 gallons. The total labor and equipment cost is 54 cents.

The total labor requirements for cleaning other items of equipment is 1.43 man-hours and the labor cost is $1.43 per 1,000 gallons.

The total cost for cleaning milk-handling equipment by the take-down pipe method is $1.97 per 1,000 gallons. The labor cost is $1.94 and the equipment cost which is charged entirely to the pipe-cleaning operation is 3 cents.

METHODS USED FOR CLEANING MILK-HANDLING EQUIPMENT IN PLANTS RECEIVING MILK IN BULK AND BOTTLING IN PAPER

The two methods used in cleaning milk-handling equipment in plants receiving milk in bulk and bottling in paper are the same as those used in plants receiving milk in cans and bottling in paper and glass, the C. I. P. pipe method and the take-down pipe method.

Cleaning Equipment in Plants Receiving Milk in Bulk and Bottling in Paper by the Cleaned-in-Place Pipe Method

The items of equipment cleaned by the C. I. P. pipe method are: 366 feet of C. I. P. pipe, a 4,000-gallon storage tank, a 300-gallon surge tank, a 500-gallon chocolate tank, an 800-gallon skim milk tank, a 100-gallon cream vat, a 12,000-pound-per-hour standardizing clarifier, an 8,000-pound-per-hour pasteurizer, an 8,600-pound-per-hour homogenizer, a 5,500-pound-per-hour separator, four 5.500- to 60,000-pound-per-hour positive-displacement pumps, four 10,000-pound-per-hour centrifugal pumps, a 75-carton-per-minute carton machine, and a can filler valve.

The cleaning methods for all items of equipment are the same as those previously described. The labor and equipment requirements for cleaning specific items of equipment are shown in table 32. The total labor and equipment cost for cleaning milk-handling equipment in plants receiving milk in bulk and bottling in paper by the C. I. P. pipe method is $1.97 per 1,000 gallons. The labor cost is $1.87 and the equipment cost is 10 cents.

Cleaning Equipment in Plants Receiving Milk in Bulk and Bottling in Paper by the Take-Down Pipe Method

With the exception of the pipe, the items of equipment cleaned and the labor and equipment requirements for cleaning these items by the take-down pipe method are the same as previously described for a plant receiving milk in bulk and bottling in paper. The take-down pipe is cleaned in the previously described manner, and the total cost for cleaning 357 feet of piping plus fittings is 54 cents per 1,000 gallons.

TABLE 23.—*Labor and equipment requirements and costs per 1,000 gallons for cleaning milk-handling equipment for a 6,000-gallon-per-day plant with a crew of 2 workers, by types of plant, by methods*

Method	Labor and equipment requirements		Labor and equipment costs		
	Labor	Equipment	Labor	Equipment	Total
Cleaning equipment in a plant receiving milk in cans and bottling milk in paper and glass by:					
	Man-hours	*Machine-hours*	*Dollars*	*Dollars*	*Dollars*
The cleaned-in-place pipe method	1. 97	[1] 2. 05	1. 97	0. 10	2. 07
The take-down pipe method	1. 94	[2] . 09	1. 94	. 03	1. 97
Cleaning equipment in a plant receiving milk in bulk and bottling milk in paper by:					
The cleaned-in-place pipe method	1. 87	[1] 2. 05	1. 87	. 10	1. 97
The take-down pipe method	1. 84	[2] . 09	1. 84	. 03	1. 87

[1] A C. I. P. tank for 0.67 machine-hour, two 10,000-lb.-per-hr. centrifugal pumps for 0.67 machine-hour each, and a pipe washer for 0.04 machine-hour.

[2] A pipe washer for 0.09 machine-hour.

The total labor and equipment cost per 1,000 gallons for cleaning milk-handling equipment by the take-down pipe method is $1.87, $1.84 for labor and 3 cents for equipment.

COMPARISON OF METHODS USED FOR CLEANING MILK-HANDLING EQUIPMENT

The total cost per 1,000 gallons of cleaning milk-handling equipment in a plant receiving milk in cans and bottling milk in paper and glass is $2.07 for the C. I. P. pipe method and $1.97 for the take-down pipe method (table 23). The difference in cost, 10 cents per 1,000 gallons, is based on the difference in pipe cleaning methods, and 7 cents of the reduced cost is caused by a reduction in the equipment costs when the take-down pipe method is used.

The total cost per 1,000 gallons of cleaning equipment in a plant receiving milk in bulk and bottling in paper is $1.97 for the C. I. P. pipe method, and $1.87 for the take-down pipe method. In this case also, costs are reduced 10 cents per-1,000 gallons when the take-down method is employed.

For both the C. I. P. pipe method and the take-down pipe method, the total cost for a plant receiving in bulk and bottling in paper is 10 cents per 1,000 gallons less than the cost for a plant receiving in cans and bottling in paper and glass. This reduction, which is based entirely on a reduction in the labor costs, is incurred because fewer items of milk-handling equipment are employed in a plant receiving milk in bulk and bottling milk only in paper.

COMPARISON OF METHODS USED IN PERFORMING FLUID MILK PLANT OPERATIONS, BY TYPES OF PLANTS

For the purposes of comparing methods used in performing fluid milk plant operations by types of plants, fluid milk plants are divided into two categories, type 1 and type 2.

Type 1 plants receives milk in cans, and bottle milk in paper and glass.

Type 2 plants receive milk in bulk and bottle in paper.

For each type of plant the methods used in performing operations are divided into two groups. One group of methods is designated combination "A" and the other group is designated combination "B". Comparisons are made between combination "A" method and combination "B" method for each type of plant by major operating cycles. Combination "B" method for a type 1 plant also are compared with combination "B" method for a type 2 plant.

COMPARISON OF METHODS USED IN A TYPE 1 PLANT

Combination "A" methods for a type 1 plant include: Receiving milk in cans by the gravity conveyor, dump bar, and dial scale method; processing milk with an unbalanced system of equipment; bottling milk in glass bottles and paper cartons; packaging milk in dispenser cans by the wash vat and filling machine method; storing milk by the case dolly method; loading out milk by the case dolly method; and cleaning milk-handling equipment by the cleaned-in-place pipe cleaning method.

Combination "B" method in a type 1 plant include: Receiving milk in cans by the power conveyor, cradle dump, and recording scale method; processing milk with a balanced system of equipment; bottling milk in glass bottles and paper cartons; packaging milk in dispenser cans by the can washer, conveyor, and filler valve method; storing milk by the 2-wheel case truck method; loading out milk by the 2-wheel case truck method; and cleaning milk-handling equipment by the take-down pipe cleaning method.

The total cost per 1,000 gallons for handling 6,000 gallons of milk in a type 1 plant by combination "A" method is $31.62 as compared with $30.45 when combination "B" method are employed (table 24). The reduction in cost in performing fluid milk operations in a type 1 plant by combination "B" method is $1.17 per 1,000 gallons. When combination "B" method are employed, some reduction in costs occurs in all operating cycles except the bottling milk cycle. The cost of bottling milk is the same for both methods. Three operating cycles are responsible for 76 percent of the reduction. The reductions are 22 cents in the receiving cycle, 39 cents in the can packaging cycle, and 28 cents in the storing cycle. The reductions resulting from the use of combination "B" method are based on reductions in both labor and equipment costs.

COMPARISON OF METHODS USED IN A TYPE 2 PLANT

Combination "A" method in a type 2 plant include receiving milk in bulk by the gravity-drain method; processing milk with an unbalanced system of equipment; bottling milk in paper cartons; packaging milk in dispenser cans by the wash vat and filling machine method; storing milk by the case dolly method; loading out milk by the case dolly method; and cleaning milk-handling equipment by the cleaned-in-place pipe cleaning method.

Table 24.—*Labor and equipment costs per 1,000 gallons for handling 6,000 gallons of milk in a type 1 plant and a type 2 plant, by combinations of methods, by major operating cycles*

Operating cycle	Type 1 plant [1]						Type 2 plant [2]					
	Combination "A" methods [3]			Combination "B" methods [4]			Combination "A" methods [5]			Combination "B" methods [6]		
	Labor	Equipment	Total	Labor	Equipment	Total	Labor	Equipment	Total	Labor	Equipment	Total
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Receiving milk	0.59	2.31	2.90	0.36	2.32	2.68	0.51	0.85	1.36	0.22	0.99	1.21
Processing milk	2.67	4.34	7.01	2.67	4.31	6.98	2.67	4.34	7.01	2.67	4.31	6.98
Bottling milk [7]	8.10	6.38	14.48	8.10	6.38	14.48	4.12	7.10	11.22	4.12	7.10	11.22
Packaging milk in cans [7]	2.42	.21	2.63	1.77	.47	2.24	2.42	.21	2.63	1.77	.47	2.24
Storing milk	1.08	.45	1.53	1.08	.17	1.25	1.33	.29	1.62	1.33	.10	1.43
Loading out milk	.60	.40	1.00	.73	.12	.85	.44	.29	.73	.54	.10	.64
Cleaning milk-handling equipment	1.97	.10	2.07	1.94	.03	1.97	1.87	.10	1.97	1.84	.03	1.87
Total	17.43	14.19	31.62	16.65	13.80	30.45	13.36	13.18	26.54	12.49	13.10	25.59

[1] Receives milk in cans and bottles 40 percent in paper and 40 percent in glass and packages 20 percent in cans.

[2] Receives milk in bulk and bottles 80 percent in paper and packages 20 percent in cans.

[3] Receiving milk in cans by the gravity-conveyor, dump bar, and dial scale method; processing milk with an unbalanced system of equipment; bottling milk in glass bottles and paper cartons; packaging milk in dispenser cans by the wash vat and filling machine method; storing milk by the case dolly method; loading out milk by the case dolly method; and cleaning milk-handling equipment by the cleaned-in-place pipe cleaning method.

[4] Receiving milk in cans by the power-conveyor, cradle dump, and recording scale method; processing milk with a balanced system of equipment; bottling milk in glass bottles and paper cartons; packaging milk in dispenser cans by the can washer, conveyor, and filler valve method; storing milk by the 2-wheel case truck method; loading out milk by the 2-wheel case truck method; and cleaning milk-handling equipment by the take-down pipe cleaning method.

[5] Receiving milk in bulk by the gravity-drain method; processing milk with an unbalanced system of equipment; bottling milk in paper cartons; packaging milk in dispenser cans by the wash vat and filling machine method; storing milk by the case dolly method; loading out milk by the case dolly method; and cleaning milk-handling equipment by the cleaned-in-place pipe cleaning method.

[6] Receiving milk in bulk by the pump-drain method; processing milk with a balanced system of equipment; bottling milk in paper cartons; packaging milk in cans by the can washer, conveyor, and filler valve method; storing milk by the 2-wheel case truck method; loading out milk by the 2-wheel case truck method; and cleaning milk-handling equipment by the take-down pipe cleaning method.

[7] Costs per 1,000 gallons based on a plant volume of 6,000 gallons.

Combination "B" method in a type 2 plant include receiving milk in bulk by the pump-drain method; processing milk with a balanced system of equipment; bottling milk in paper cartons; packaging milk in dispenser cans by the can washer, conveyor, and filler valve method; storing milk by the 2-wheel case truck method; loading out milk by the 2-wheel case truck method; and cleaning milk-handling equipment by the take-down pipe cleaning method.

The total cost per 1,000 gallons for handling 6,000 gallons of milk in a type 2 plant by combination "A" method is $26.54, as compared with $25.59 when combination "B" method is employed. The reduction in cost in performing fluid milk operations in a type 2 plant by the combination "B" method is 95 cents per 1,000 gallons. When the combination "B" method is employed, some reduction in cost occurs in each operating cycle except bottling. The cost for bottling milk is the same for both methods. The two operating cycles responsible for the greatest reduction in cost are packaging milk in cans with a reduction of 39 cents, and storing milk with a reduction of 19 cents.

COMPARISON OF METHODS IN A TYPE 1 AND TYPE 2 PLANT

In performing fluid milk plant operations by the combination "A" method, the total cost per 1,000 gallons for handling 6,000 gallons in a type 1 plant is $31.62, as compared with $26.54 for a type 2 plant. The cost for performing fluid milk plant operations by the combination "A" method is $5.08 per 1,000 gallons less in the type 2 plant. The reduction in costs amount to approximately $9,500 annually. Two operating cycles are responsible for 94 percent of the reduction—receiving and bottling. The cost for receiving milk in bulk is $1.36 per 1,000 gallons as compared to $2.90 for receiving milk in cans. The reduction in cost when receiving milk in bulk is $1.54 per 1,000 gallons. The annual reduction should be approximately $2,880. The cost for bottling milk in paper and glass is $14.48 as compared with $11.22 for bottling in paper. The reduction in cost when milk is bottled in paper is $3.26 per 1,000 gallons. The annual reduction should be about $6,100.

In performing fluid milk plant operations by the combination "B" method, the total cost per 1,000 gallons for handling 6,000 gallons in a type 1 plant is $30.45, as compared with $25.59 for a type 2 plant. The cost for performing fluid milk plant operations by the combination "B" method is $4.86 per 1,000 gallons less in the type 2 plant. The reduction in costs amounts to approximately $9,000 annually. Two operating cycles are responsible for 97 percent of the reduction—receiving and bottling. The cost for receiving milk in bulk is $1.21 per 1,000 gallons, as compared to $2.68 for receiving milk in cans. The reduction in the cost when receiving milk in bulk is $1.47 per 1,000 gallons. The annual reduction is approximately $2,750. The costs for bottling milk in paper and glass and in paper only are the same as for a type 1 plant.

EFFECTS OF VOLUME OF MILK HANDLED ON LABOR AND EQUIPMENT COSTS

The assumed daily volume of 6,000 gallons of milk is increased to 10,000 gallons to analyze the effects of plant volume on labor and equipment costs. Costs per 1,000 gallons for handling a volume of 10,000 gallons are computed for each of the methods used in performing the operations in each major operating cycle. The methods are grouped into combination "A" and combination "B" for a type 1 and a type 2 plant. They were grouped in the same manner as they were for a plant handling 6,000 gallons of milk daily. The labor and equipment costs per 1,000 gallons for handling 10,000 gallons of milk daily are compared for combination "A" and "B" methods by major operating cycles for each type of plant. The cost per 1,000 gallons is compared for handling 10,000 and 6,000 daily for both methods and types of plant by major operating cycles.

EFFECTS OF VOLUME OF MILK HANDLED ON LABOR AND EQUIPMENT COSTS IN A TYPE 1 PLANT

The total cost per 1,000 gallons for handling 10,000 gallons of milk with combination "A" in a type 1 plant is $27.15 as compared with $25.93 per 1,000 gallons when combination "B" is used. The reduction in cost per 1,000 gallons for handling milk with combination "B" is $1.22. Reduced costs from the use of combination "B" is based on reductions in both labor and equipment costs.

The total cost per 1,000 gallons for handling 6,000 gallons of milk daily with the combination "A" method in a type 1 plant is $31.62, as compared with $27.15 per 1,000 gallons for 10,000 gallons. The total cost per 1,000 gallons for handling 6,000 gallons daily with combination "B" is $30.45 as compared with $25.93 per 1,000 gallons for handling 10,000 gallons.

Costs are reduced in a type 1 plant by $4.47 per 1,000 gallons when the volume is increased from 6,000 gallons daily to 10,000 gallons and the combination "A" method is used. A reduction in costs of $4.52 results when combination "B" is used. With both methods the reduction in costs are approximately equally divided between labor and equipment.

A reduction in costs results in all operating cycles in a type 1 plant handling 10,000 gallons of milk daily when either combination "A" or "B" methods are employed. The largest reductions in costs for both methods occur in the processing and bottling cycles, table 25. Most reductions in the processing cycle are in the labor cost. The increase in volume necessitates a change in the schedule of processing operations. About 12½ hours are required for processing with an unbalanced system of equipment and 11 hours with a balanced system. Two workers properly scheduled should perform the operations. There is a slight reduction in equipment costs. Most of the reduction in the bottling cycles is in the equipment cost, although a slight reduction occurs in the labor cost.

The equipment used for performing all operations when a volume of 10,000 gallons of milk daily is handled is shown in table 28.

TABLE 25.—*Labor and equipment costs per 1,000 gallons for handling 6,000 and 10,000 gallons of milk per day in a type 1 plant, by combinations of methods, by major operating cycles* [1]

Operating cycle	Labor and equipment costs											
	6,000-gallon-per-day plant						10,000-gallon-per-day plant					
	Combination "A" methods [2]			Combination "B" methods [3]			Combination "A" methods [2]			Combination "B" methods [3]		
	Labor	Equipment	Total	Labor	Equipment	Total	Labor	Equipment	Total	Labor	Equipment	Total
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Receiving milk	0. 59	2. 31	2. 90	0. 36	2. 32	2. 68	0. 59	2. 03	2. 62	0. 36	2. 00	2. 36
Processing milk	2. 67	4. 34	7. 01	2. 67	4. 31	6. 98	1. 60	4. 08	5. 68	1. 60	4. 02	5. 62
Bottling milk	8. 10	6. 38	14. 48	8. 10	6. 38	14. 48	7. 44	5. 06	12. 50	7. 44	5. 06	12. 50
Packaging milk in cans	2. 42	. 21	2. 63	1. 77	. 47	2. 24	2. 42	. 15	2. 57	1. 77	. 36	2. 13
Storing milk	1. 08	. 45	1. 53	1. 08	. 17	1. 25	1. 08	. 44	1. 52	1. 08	. 16	1. 24
Loading out milk	. 60	. 40	1. 00	. 73	. 12	. 85	. 60	. 39	. 99	. 73	. 11	. 84
Cleaning milk-handling equipment	1. 97	. 10	2. 07	1. 94	. 03	1. 97	1. 20	. 07	1. 27	1. 22	. 02	1. 24
Total	17. 43	14. 19	31. 62	16. 65	13. 80	30. 45	14. 93	12. 22	27. 15	14. 20	11. 73	25. 93

[1] Plant receives milk in cans and bottles 40 percent in paper, 40 percent in glass and packages 20 percent in cans.

[2] Receiving milk in cans by the gravity conveyor, dump bar, and dial scale method; processing milk with an unbalanced system of equipment; bottling milk in paper cartons and glass bottles, packaging milk in dispenser cans by the wash vat and filling machine method; storing milk by the case dolly method; loading out milk by the case dolly method; and cleaning milk-handling equipment by the cleaned-in-place pipe cleaning method.

[3] Receiving milk in cans by the power conveyor, cradle dump, and recording scale method; processing milk with a balanced system of equipment; bottling milk in paper cartons and glass bottles; packaging milk in dispenser cans by the can washer, conveyor, and filler valve method; storing milk by the 2-wheel case truck method; loading out milk by the 2-wheel case truck method; and cleaning milk-handling equipment by the take-down pipe cleaning method.

EFFECTS OF VOLUME OF MILK HANDLED ON LABOR AND EQUIPMENT COSTS IN A TYPE 2 PLANT

The total cost per 1,000 gallons for handling 10,000 gallons of milk daily with combination "A" in a type 2 plant is $22.01 as compared with $21.01 when combination "B" is used. The reduction in costs per 1,000 gallons for handling milk with combination "B" is $1. The reduction in costs resulting from the use of the combination "B" method is in both labor and equipment costs.

The total cost per 1,000 gallons for handling 6,000 gallons of milk daily with combination "A" in a type 2 plant is $26.54 as compared with $22.01 per 1,000 gallons for 10,000 gallons. The total cost per 1,000 gallons for handling 6,000 gallons of milk daily with combination "B" is $25.59 as compared with $21.01 for handling 10,000 gallons.

Costs are reduced in a type 2 plant by $4.53 per 1,000 gallons when the volume is increased from 6,000 gallons daily to 10,000 gallons and combination "A" is used. A reduction in costs of $4.58 results when combination "B" is used. With both methods the reduction in costs are approximately equally divided between labor and equipment.

A reduction in costs results in all operating cycles in a type 2 plant when the volume is increased from 6,000 to 10,000 gallons daily when either combination "A" or "B" methods are employed. The largest reduction in cost for both combination "A" and "B" methods, however, occurs in the processing and bottling cycles, table 26. The effects of increased volume on costs in the processing cycle are the same as those described for a type 1 plant. The reduction in costs in the bottling cycle is realized primarily by the increased utilization of equipment.

Table 26.—*Labor and equipment costs per 1,000 gallons for handling 6,000 gallons and 10,000 gallons of milk per day in a type 2 plant, by combinations of methods, by major operating cycles* [1]

Operating cycle	Labor and equipment costs											
	6,000-gallon-per-day plant						10,000-gallon-per-day plant					
	Combination "A" methods [2]			Combination "B" methods [3]			Combination "A" methods [2]			Combination "B" methods [3]		
	Labor	Equipment	Total	Labor	Equipment	Total	Labor	Equipment	Total	Labor	Equipment	Total
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Receiving milk	0. 51	0. 85	1. 36	0. 22	0. 99	1. 21	0. 49	0. 84	1. 33	0. 20	0. 96	1. 16
Processing milk	2. 67	4. 34	7. 01	2. 67	4. 31	6. 98	1. 60	4. 08	5. 68	1. 60	4. 02	5. 62
Bottling milk	4. 12	7. 10	11. 22	4. 12	7. 10	11. 22	3. 91	5. 02	8. 93	3. 91	5. 02	8. 93
Packaging milk in cans	2. 42	. 21	2. 63	1. 77	. 47	2. 24	2. 42	. 15	2. 57	1. 77	. 36	2. 13
Storing milk	1. 33	. 29	1. 62	1. 33	. 10	1. 43	1. 28	. 29	1. 57	1. 28	. 09	1. 37
Loading out milk	. 44	. 29	. 73	. 54	. 10	. 64	. 44	. 28	. 72	. 54	. 08	. 62
Cleaning milk handling equipment	1. 87	. 10	1. 97	1. 84	. 03	1. 87	1. 14	. 07	1. 21	1. 16	. 02	1. 18
Total	13. 36	13. 18	26. 54	12. 49	13. 10	25. 59	11. 28	10. 73	22. 01	10. 46	10. 55	21. 01

[1] Plant receives milk in bulk and bottles 80 percent in paper and packages 20 percent in cans.

[2] Receiving milk in bulk by the gravity-drain method; processing milk with an unbalanced system of equipment; bottling milk in paper cartons; packaging milk in dispenser cans by the wash vat and filling machine method; storing milk by the case dolly method; loading out milk by the case dolly method; and cleaning milk-handling equipment by the cleaned-in-place pipe cleaning method.

[3] Receiving milk in bulk by the pump-drain method; processing milk with a balanced system of equipment; bottling milk in paper cartons; packaging milk in dispenser cans by the can washer, conveyor, and filler value method; storing milk by the 2-wheel case truck method; loading out milk by the 2-wheel case truck method; and cleaning milk-handling equipment by the take-down pipe cleaning method.

LAYOUT FOR A FLUID MILK PLANT

The preparation of a layout for a fluid milk plant should give consideration to at least four major factors: (1) Product and container flow, (2) space utilization, (3) equipment arrangement, and (4) future expansion.

The paths of flow for products and containers should be short and direct, and should be designed to minimize plant congestion. This necessitates not only the proper arrangement of equipment, but the proper location of related work areas.

A milk plant should be designed for the greatest utilization of space. Before room sizes are determined, the space requirements of each item of equipment should be ascertained and allowances made for the working space required around each machine. In the case of storage rooms, the number of items to be stored and the required floor space must be determined. Allowances should be made for aisles in all rooms, the size of the aisles being dependent upon the types of traffic to be handled.

The arrangement of equipment should provide for economy of movement, and for the most efficient performance of operations. Such an arrangement of equipment should insure minimum walking distances for workers. The arrangement of equipment should also provide for the most direct flow, and therefore, for a minimum footage of piping.

The plant should be designed so that expansion will not present a major construction problem. Removable non-bearing walls should be used where expansion is anticipated, and plans for expansion should provide for the removal of a minimum amount of exterior wall.

Dairy plant operators planning the construction of new plants or the expansion of existing plants should consult engineers, dairy technologists, and health department officials for assistance in the preparation of actual plant designs.

PROPOSED LAYOUT FOR A FLUID MILK PLANT HANDLING 6,000 GALLONS OF MILK PER DAY

To illustrate the major principles of plant layout for a fluid milk plant, a proposed layout for a 6,000 gallon a day plant is shown in figure 35. The plant is designed for the receipt of milk in bulk and the bottling and packaging of milk in

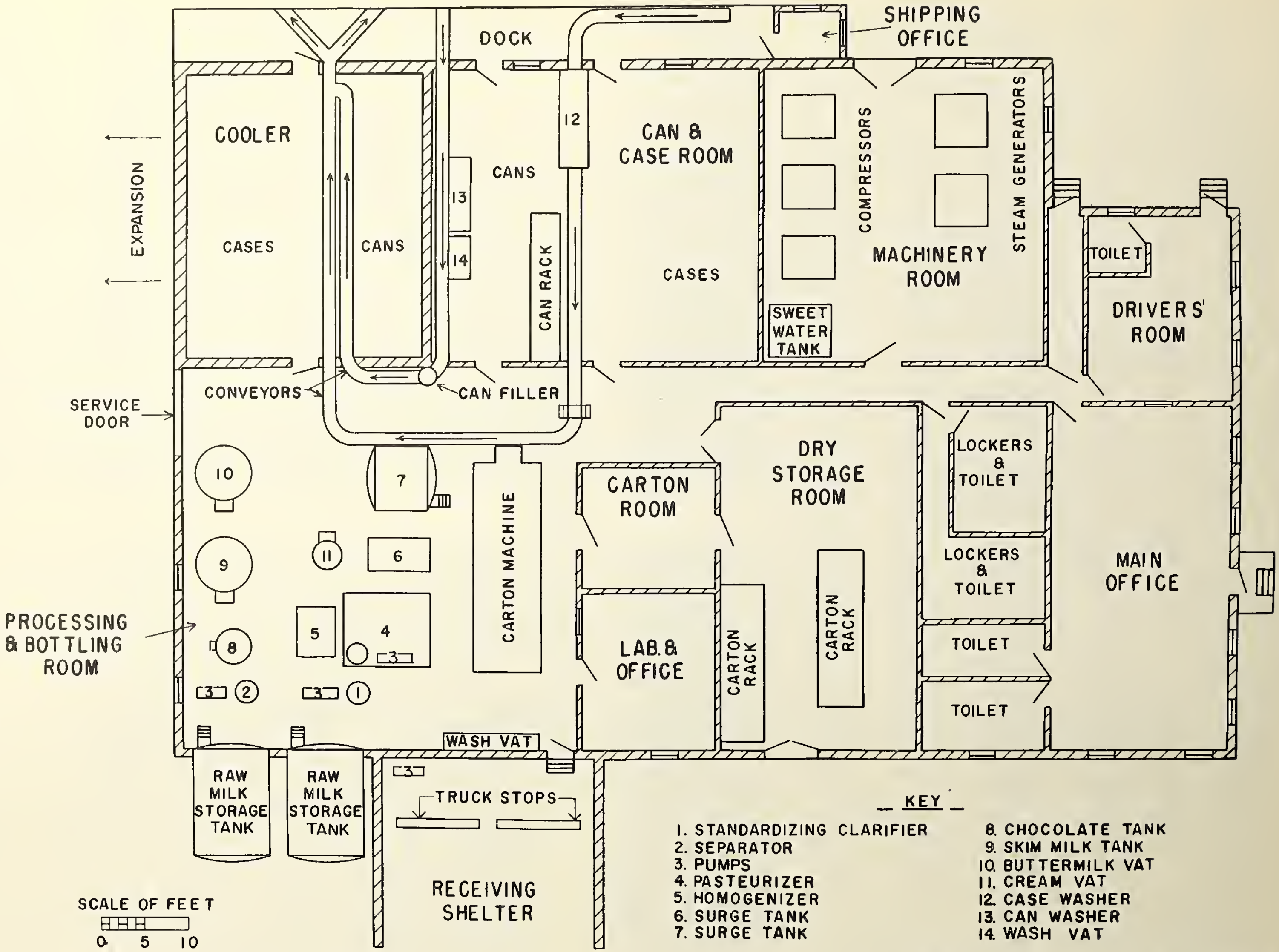

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Figure 35.—Proposed layout for a 6,000-gallon-per-day fluid milk plant that receives milk in bulk, bottles in paper cartons, and packages in dispenser cans.

paper cartons and dispenser cans (type 2). The plant covers an area 124 feet long and 108 feet wide. The major parts of the plant are the receiving area, the processing and bottling room, the cooler, the can and case room, the dry storage area, the laboratory, the offices, the drivers' room, the machinery room, and the toilets.

RECEIVING AREA

A drive-in shelter area should be provided at fluid milk plants for the receipt of bulk milk from truck tanks. Space should be available for two trucks in the receiving area, so that the most continuous flow of milk into the plant can be attained by draining one tank while another tank is being checked and cleaned.

Layout of area—The size of the shelter is dependent upon the size of the trucks to be accommodated. Although farm pickup trucks in Georgia are usually 1,500- to 1,800-gallon tankers, it is occasionally necessary to receive milk from 3,000-gallon trucks when supplementary milk is purchased from other sources. On the basis of an 8-foot truck width, a 12-foot space is allowed for positioning trucks by the drivers, and to guard against damage to either the trucks or the plant facilities. The minimum inside width of the stall, therefore, should be 24 feet. The ceiling height should allow the receiving worker ample space to work on top of the trucks, as he must climb on top, to check the milk and to clean the tank. The average height of 3,000-gallon tankers is 9 feet, so the ceiling height should not be less than 14 feet.

The floor of the shelter should be of a material which is hard and impervious, easily cleaned, and capable of supporting the necessary load. The grade of the floor should be such that the milk will flow to the rear of the truck during draining, and should also provide for adequate floor drainage. A raised concrete stop, approximately 6 inches high, should be built near the rear of each truck space to prevent trucks from backing into the wall of the plant.

Sufficient space should be allowed behind the trucks to permit the cleaning of tank drain valves, and space should also be provided for a storage cabinet for cleaning and receiving supplies. Three-thousand-gallon trucks approximate a total length of 24 feet. Shelters should be of sufficient depth to protect the top tank port from the weather, but should not necessarily enclose the entire truck. Allowing 5 feet behind the trucks, a shelter depth of 22 feet should be adequate for the receipt of milk from tank trucks in Georgia. The interior walls and ceiling of the receiving area should be painted a light color, and sufficient lighting should be available to provide at least 20 foot-candles throughout the shelter. A screened door should connect the receiving area and the main plant.

Arrangement of equipment—The basic items of equipment required for the receipt of bulk milk are a milk pump, piping, a flexible drain hose, and the storage tanks. The pump is located on the floor, and beside the wall adjoining the processing area. The piping extends through the same wall, and is connected to the pump. The drain hose, which is attached to the pump, should be of sufficient length to reach the trucks, but should not be of such length that it coils all over the floor. The storage tanks are beside the receiving area, and project through the wall of the processing and bottling room. The faces of the tanks are inside the room, but the main bodies of the tanks are outside of the plant.

The shelter should be equipped with two water hoses. One hose should be kept at the rear of the shelter for use in cleaning tank drain valves and rinsing the walls and floor. The other hose should be suspended from a self-winding reel attached to the ceiling near the center of the room. This hose would be used for cleaning tanks, and the convenient location would eliminate the necessity of carrying a hose while climbing onto the truck. Figure 36 illustrates the flow of raw milk from the receiving area to the raw milk storage tanks.

PROCESSING AND BOTTLING ROOM

Because of the relationship of the processing and bottling operations, the two work areas are incorporated in one room. The room is separate from all other operational areas, but is centrally located in relation to associated operations.

Layout of room—The walls of the processing and bottling room should be tiled or painted a light color, and should be easily cleaned and impervious. The floors, which should also be easily cleaned and impervious, should be designed to support the weight of all items of equipment. The floors should be sloped to provide adequate drainage, and the location of drains should be such that drain water does not cross aisles or work areas. The light intensity in the room should be at least 20 foot-candles.

Traffic from outside the plant is usually discouraged in processing rooms, so the only outside exit should be that leading to the receiving area. There should be one 10-foot service door in the room. The door will be used for the movement of large items of equipment in and out of the room, but will normally remain closed. The proposed processing and bottling room is 44 feet 6 inches long by 44 feet wide.

Arrangement of equipment—The majority of the space in the processing and bottling room would be occupied by processing equipment. The equipment is arranged to provide the most direct flow of homogenized and regular milk, which constitute 81 percent of the plant volume, through the room (fig. 36). The equipment concerned

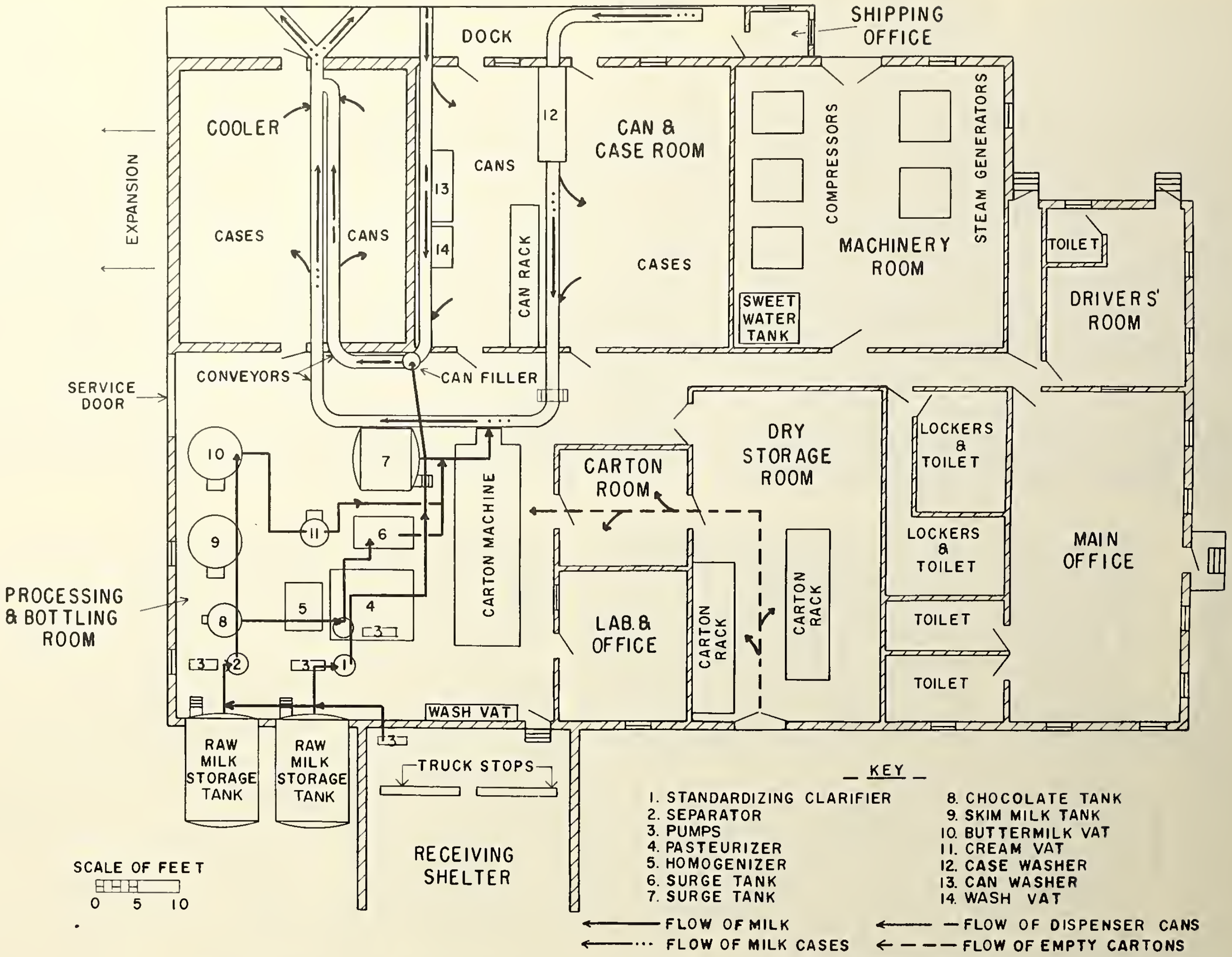

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Figure 36.—The flow of milk cases, milk, dispenser cans, and empty cartons through the proposed plant.

with the preparation of by-products is not arranged for a direct product flow, but is arranged to provide the most efficient flow of each product through the necessary equipment.

The standardizing clarifier and the separator are directly in front of the storage tanks, and are separated from the tanks by a 3-foot aisle. Directly behind the standardizing clarifier are the pasteurizer, the homogenizer, and the surge tanks. Behind the separator are the tanks and processing vats. Space should be allowed around all items of equipment for servicing and cleaning, and 3- or 4-foot aisles should provide access to each tank and machine. It is not necessary to leave aisle space along the wall, but sufficient space should be allowed behind tanks for cleaning purposes.

The carton machine and the can filler should be located close to the surge tanks. The carton machine is placed parallel to the carton room wall, and separated from that wall by a 4-foot aisle. Location of the machine beside the carton room reduces the carton hauling distance to a minimum. The carton machine is bounded at the discharge end by a case conveyor. The can filler is situated next to a wall, and directly above the can conveyor.

The case and can conveyors are located at the packaging end of the room. The case conveyor flows directly past the accumulating table of the carton machine, enabling the worker to case cartons with a minimum of motion and effort. The height of the case conveyor is based on the height of the adjustable accumulating table, which is approximately 30 inches high when quarts are packaged. A conveyor height of 19½ inches places the top of the case on a level with the table, and the cartons can be lowered into the case. When pints and half-pints are packaged, the accumulating table is a few inches higher than the case.

The can conveyor is close to the wall, and approximately six feet from the case conveyor. The 6-foot space between conveyors allows ample room for the casing worker and the can filling and sealing crew to perform their respective operations. The height of the can conveyor is 19½ inches above the floor.

The proper arrangement of processing and bottling equipment should insure a well engineered system of piping. The design of the system should provide for the greatest utilization of pipe, and the shortest line of flow (fig. 37). Placing the skim milk, chocolate, and buttermilk tanks in a row, for instance, allows the use of one pipe to convey the skim milk from the separator to any of the three tanks. The system should also be designed so that one section of pipe may be used for different products. Where possible, the overhead piping should be hung at a height of approximately 6 feet 6 inches. This height would prevent the pipe from obstructing traffic, but would place it within easy reach for removal and assembly. The wash vat should be placed in a centrally located, but out-of-the-way location. The wash vat is approximately 10 feet long, and an additional open space of 10 or more feet must be provided beside the vat to allow the workers to remove the pipes from the scrub brush.

COOLER ROOM

The cooler room should be designed for receiving, storing, and loading out containers efficiently. The space requirements are based almost entirely on the size and number of containers to be stored.

Layout of room—The cooler is situated adjacent to an exterior wall, so that containers of milk can be transferred directly from the room to delivery trucks. The walls, ceiling, floor, and doors should be insulated. The thickness of the insulation will depend to some extent on local conditions, but it should be sufficient to maintain a temperature of approximately 35° F. There are no windows, and a minimum number of doors. Lighting in the room should provide a minimum of four foot-candles at a distance of 30 inches from the floor. Conveyor ports should be built into the walls to provide passage for cases and cans. The ports should be at conveyor height, and only large enough to admit the cans or cases. During the day the ports are partially sealed by either swinging metal doors or a canvas curtain, each of which serves to retain the cold air, but is pushed open by the passing can or case. When the cooler is not in use, the ports are sealed by insulated doors.

The cooler is divided into two areas, a can storage area and a case storage area. The cans should be stacked two high along the floor. On the basis of storing 240 cans daily, plus an allowance for an additional 20 percent, 108 square feet in the cooler is provided for can storage.

The cases in the cooler should be stacked 5 high on the floor. On the basis of 1,032 cases with an allowance for a 20 percent carry-over, 390 square feet is provided for the storage of cases. The cases should be stacked close together, but separate areas should be designated for the storage of each product and each container size.

An area near the load-out end of the cooler should be set aside for the storage of returned containers which are to be loaded out the following day. Both the case storage area and the can storage area are designed to reduce the handling distance between the stacks and the conveyors. To accomplish this, the stacking areas should be long and narrow, with the long dimension being parallel to the conveyor. The cooler measures 26 feet 9 inches by 32 feet 6 inches.

A dock is located outside of the plant and along the cooler wall. The dock is 75 feet 6 inches long and 6 feet wide, and is used for shipping out packaged milk and receiving empty cases and cans. At the far end of the dock is a small shipping office, 7 feet long by 5 feet 6 inches wide, in which daily shipping records are kept. The dock

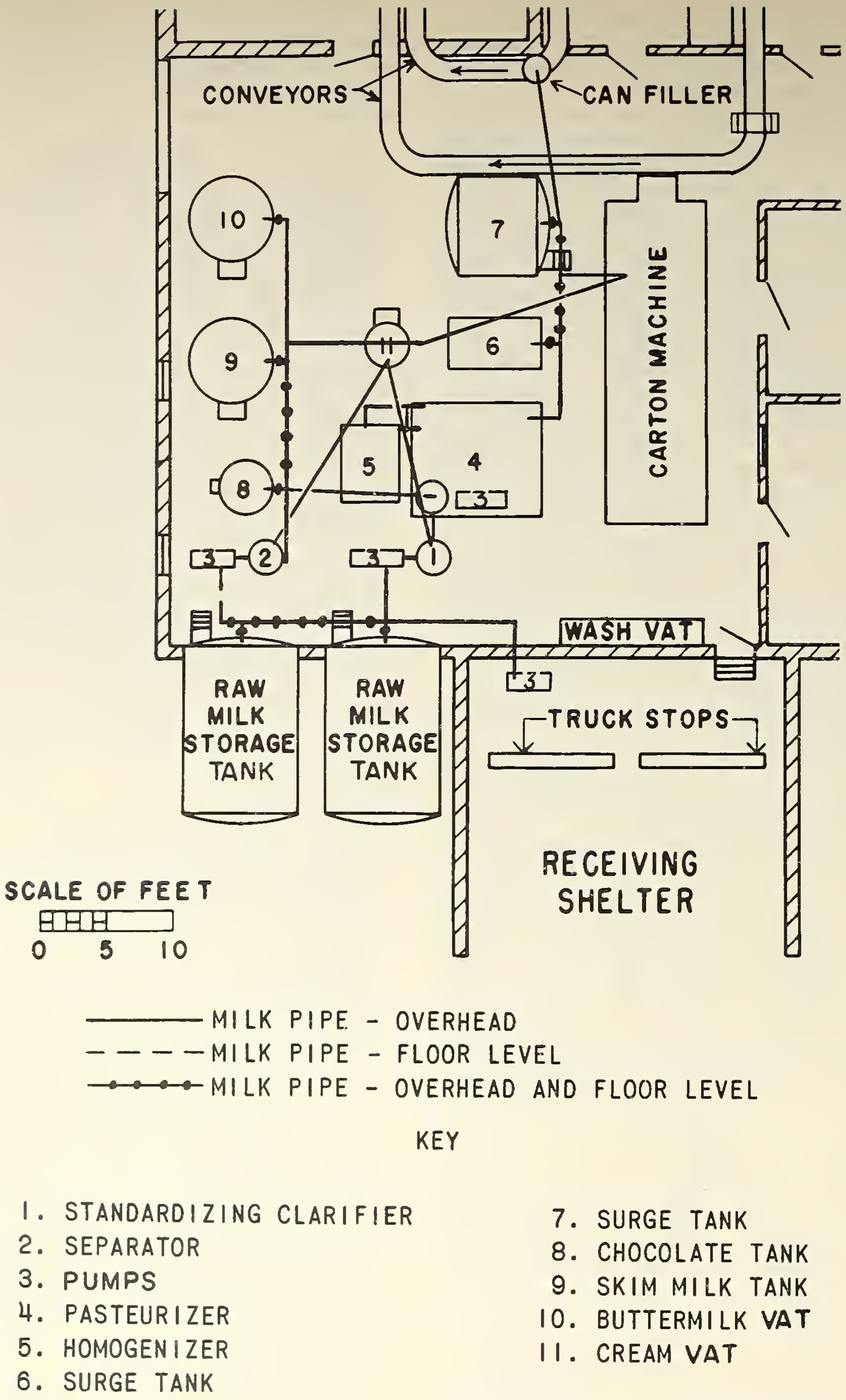

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Figure 37.—Location of piping in the processing and bottling room of the proposed plant.

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should be at truck-bed height. The actual height is dependent upon the bed-height of the trucks employed.

Arrangement of equipment—The only items of stationary handling equipment in the cooler are the two conveyors. The conveyors enter the room side by side from the processing and bottling room, and divide the room into two storage areas. The case conveyor runs straight through the room and out to the dock, where it forms a "Y", one section of the "Y" being a gravity conveyor. By forming the "Y", the conveyor may be used to load two trucks consecutively. The can conveyor runs parallel to the case conveyor, and is joined to the latter by a section of gravity conveyor at the load-out end of the room. Since each truck carries just a few cans it is not considered necessary to provide a separate can conveyor, at the truck loading point. Each conveyor should be separated from the stacks by a 4-foot working aisle.

The cooling units are suspended from the ceiling in order to conserve floor space. To avoid any unnecessary loss of refrigeration, the units should be located so that they will not blow air directly toward either doorway.

CAN AND CASE ROOM

As empty cans and cases are returned to the plant, they are unloaded from the trucks and conveyed directly to the can and case room. The room, therefore, should be located adjacent to the exterior wall adjoining the dock.

Layout of room—The walls of the can and case room should be painted a light color, and should be impervious. Since the walls are regularly rinsed and are often subjected to hot water and steam sprays, the wall paint should be highly resistant to hot and cold water and to steam.

The room should have a number of hose outlets appropriately spaced. The floor should be well sloped, and particular attention should be provided to locating drains near washers, and away from the areas where clean cases and cans are stacked. The floors should be constructed of a material which is easily cleaned and impervious to moisture, acids, and cleaning solutions. Since cases and cans are often dropped and dragged across the floor, the flooring should be resistant to wear and chipping. There are doors at the ends of each aisle, since any traffic between the dock and the plant would be encouraged to use the can and case room rather than the cooler. The doors leading to the processing and bottling room should be screened. Conveyor ports are located at the two ends of the room to permit the passage of cases and cans.

The room should be well equipped with ventilators for the removal of steam and any odors emanating from the unwashed cans. The lighting may be artificial light or natural light provided by windows or skylights. The light intensity, however, should be at least 10 foot-candles throughout the room. Additional light should be provided in the can washing area, however, to facilitate the inspection of cans.

As cans are removed from the incoming conveyor, they are stacked four high in a separate area against the exterior wall. After having been washed, the cans would be stacked three high in a can rack opposite the rinse vat. On the basis of a 2-day supply of cans, plus an additional 20 percent, a total of 576 cans, a can storage area of 195 square feet will be required. The case storage area should be large enough for the storage of a 2-day supply of cases, plus an allowance for an additional 20 percent, a total of 2,477 cases. For the best utilization of floor space, the cases which are relatively easy to handle, should be stacked eight high. The cases should be stacked against the wall so that the storage area is bounded by walls on three sides and by a four-foot working aisle on the fourth side.

An area of 488 square feet is provided for case storage. Since the cases are washed as they enter the room, and since there is no variation in the size of cases, it is not necessary to segregate them in the storage area. The room is 36 feet 6 inches long by 33 feet 6 inches wide.

Arrangement of equipment—The can washing area is equipped with a conveyor, a can washer, a rinse vat, and a can rack. The conveyor is located along the side wall. The can washer and rinse vat are placed against the conveyor at a point midway through the room. Their location is such that the unwashed cans are close to the washer and the can rack is close to the rinse vat. Such an arrangement reduces the operator's walking time to a minimum. The can washer and stacking area are separated by a four-foot aisle. The can rack or racks should be frame-type racks, and are usually constructed of pipe or tubing.

The case handling equipment consists of a case washer and a conveyor. The case washer, measuring approximately 11 feet by 3 feet, is located at the exterior wall, and cases are washed as they enter the room. The conveyor passes through the washer, continues straight through the room, and through the opposite wall.

DRY STORAGE AREA

The dry storage area is used for the storage of plant supplies. These supplies include containers, product ingredients such as sugar and chocolate, soaps, detergents, spare parts, washers, gaskets, and other items necessary for the operation of a dairy. The space requirements for the most part are based upon the types of product manufactured and the types of containers used. Dairy plants which make ice cream, and those which package milk in glass bottles, for instance, usually have large storage space requirements. Fluid milk plants which package milk primarily in cartons, however, require less space for dry storage.

Layout of area—The dry storage area in a fluid milk plant actually consists of two rooms, the dry storage room, and the carton room. The light intensity in the storage room should be at least four foot-candles at a distance of 30 inches from the floor. As a rule there is very little moisture in the storage room, so any interior-type wall paint can be used for the walls and ceiling. Any type of flooring which will support the weight of racks, and resist wear from hand trucks is adequate for the storage rooms.

Empty cartons are packed in boxes measuring approximately 12 inches by 15 inches by 17 inches. Each box contains either 500 quart cartons, 1,000 pint cartons, or 1,000 half-pint cartons. Racks are provided in the dry storage room for a one-month's supply of cartons, or 1,125 boxes. Carton storage accounts for approximately one-third of the floor space. The remainder of the space in the dry storage room would be used for aisles, cabinets, and miscellaneous supplies. The supplies will be unloaded at a 6-foot receiving entrance. The floor of the storage room is at an average truck-bed height above the ground level of the unloading area, and it is not necessary to provide a receiving dock. The dry storage room measures 22 feet by 39 feet 3 inches.

The carton room is situated between the dry storage room and the processing and bottling room, providing a direct flow of cartons from storage to the carton machine. The cartons should be conditioned by a constant atmosphere of 70° F. and 30 percent relative humidity. Space is provided for the storage of a 2-week supply of cartons, or 520 boxes, in the room on floor racks. The carton room is 15 feet long by 14 feet wide, and is divided by a 4-foot aisle.

Arrangement of equipment—The only items of stationary equipment in the dry storage room are carton racks. Two racks are used for stacking cartons in the storage room. Each rack is 18 feet long by 5 feet wide, and accommodates 576 boxes. Simple wooden racks with removable shelving should be adequate for this purpose. The racks, which are loaded and unloaded from the same side, are located on opposite sides of a 6-foot aisle leading to the receiving entrance. One rack is separated by five feet from the exterior wall to provide a passage around the rack. The aisle behind that rack should be used for wall-type cabinets. Other supply items should be stacked on the floor or on floor racks at the opposite end of the room. The boxes in the carton room should be stacked on floor racks on each side of the aisle. The boxes should be stacked four deep, five high, and thirteen wide.

LABORATORY AND OFFICES

The laboratory and the production manager's office are combined in one room adjacent to the processing and bottling room. The laboratory is used for performing quality and composition analyses on milk. Tests are also performed on bottled milk to determine possible sources of contamination. Laboratories should have ample counter space, and are usually equipped with a centrifuge, a refrigerator, ovens, and miscellaneous laboratory tools and supplies. The room measures 15 feet by 18 feet.

An area measuring 20 feet by 39 feet 3 inches, is provided as main office space. The main office is located at the front of the building. Space is available for a plant manager, an accountant, a sales manager, a cashier, a receptionist, and secretaries.

DRIVERS' ROOM

Adjoining the main office is the drivers' room. This room, measuring 16 feet by 21 feet, is for the use of the drivers in preparing their records, receipts, and cash payments. The wall separating the drivers' room and the main office contains a teller-type window through which the drivers conduct their business with the cashier.

MACHINERY ROOM

The machinery is situated in a corner of the building, and contains all refrigerating and heating equipment. The room is 31 feet long by 33 feet 6 inches wide. Space is available for compressors, steam generators, a sweet water (cold water) tank, an electrical panel, and a small maintenance area. The latter would include a work bench and such machines as a drill press and a portable electric welder, and should be used for the repair of plant equipment and for minor service work.

TOILETS

The area between the main office and the dry storage room houses the toilet facilities. Two small toilets are provided for office personnel. For plant personnel, two locker and toilet rooms are provided. The entire toilet area is 14 feet wide by 39 feet 3 inches long.

EXPANSION OF PLANT

The layout of the 6,000-gallon-per-day milk plant shown in figure 36 provides for future expansion. Figure 38 shows the plant expanded to handle a daily volume of 10,000 gallons of milk. The overall plant would cover an area 145 feet long by 108 feet wide, an increase in length of 21 feet. All expansion would be in one direction. The expansion would necessitate the removal of one exterior wall and five interior walls, but would not necessitate the removal of the dock or the receiving shelter (fig. 39). The rooms affected by an increase in plant volume would be the processing and bottling room, the cooler, the can and case room, the dry storage room, and the carton room.

The size of the expanded processing and bottling room would be 55 feet by 44 feet, an increase in length of 10 feet 6 inches. The enlargement of the room would be based on an increase in the number

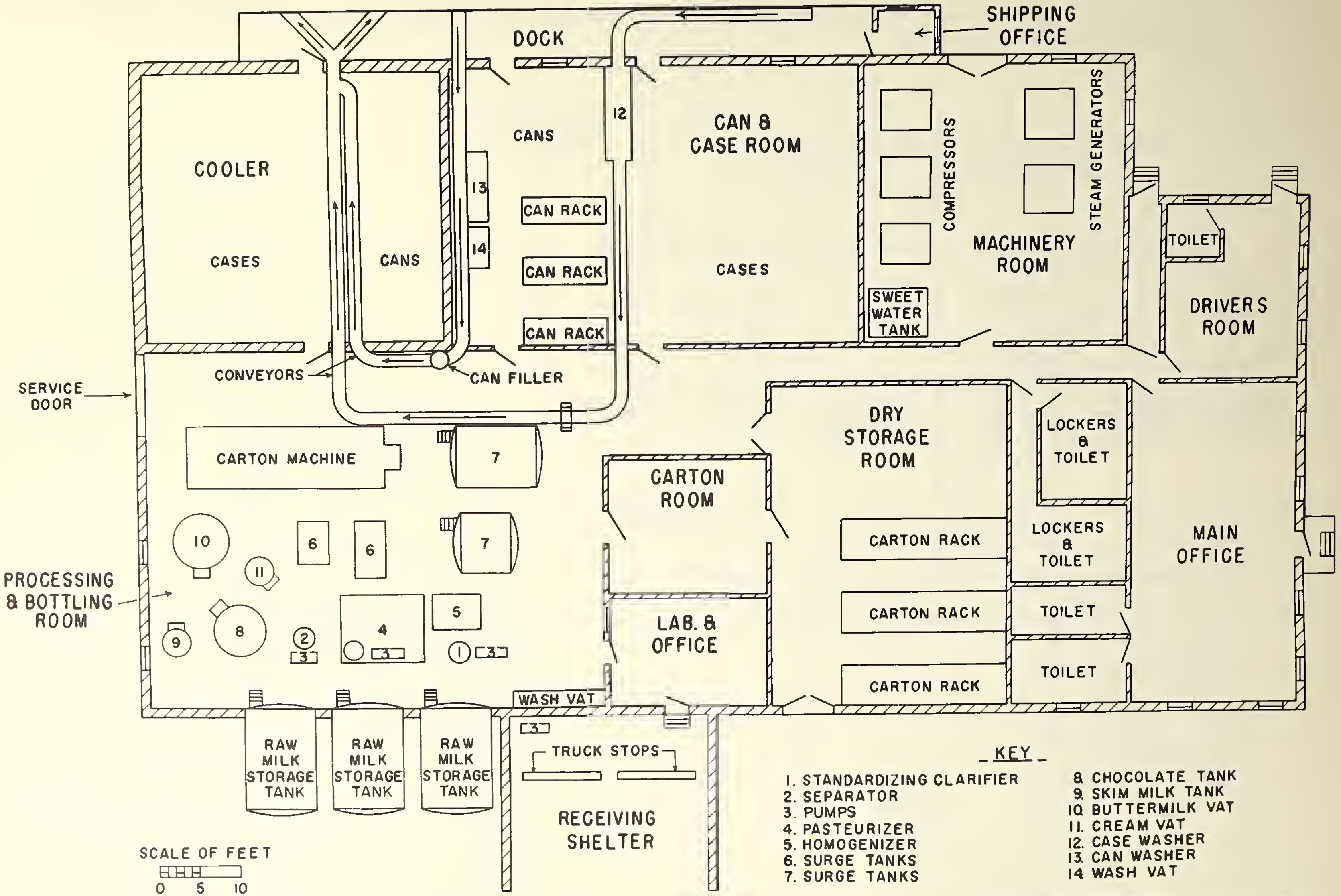

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Figure 38.—Layout of proposed plant expanded to handle a daily volume of 10,000 gallons of milk.

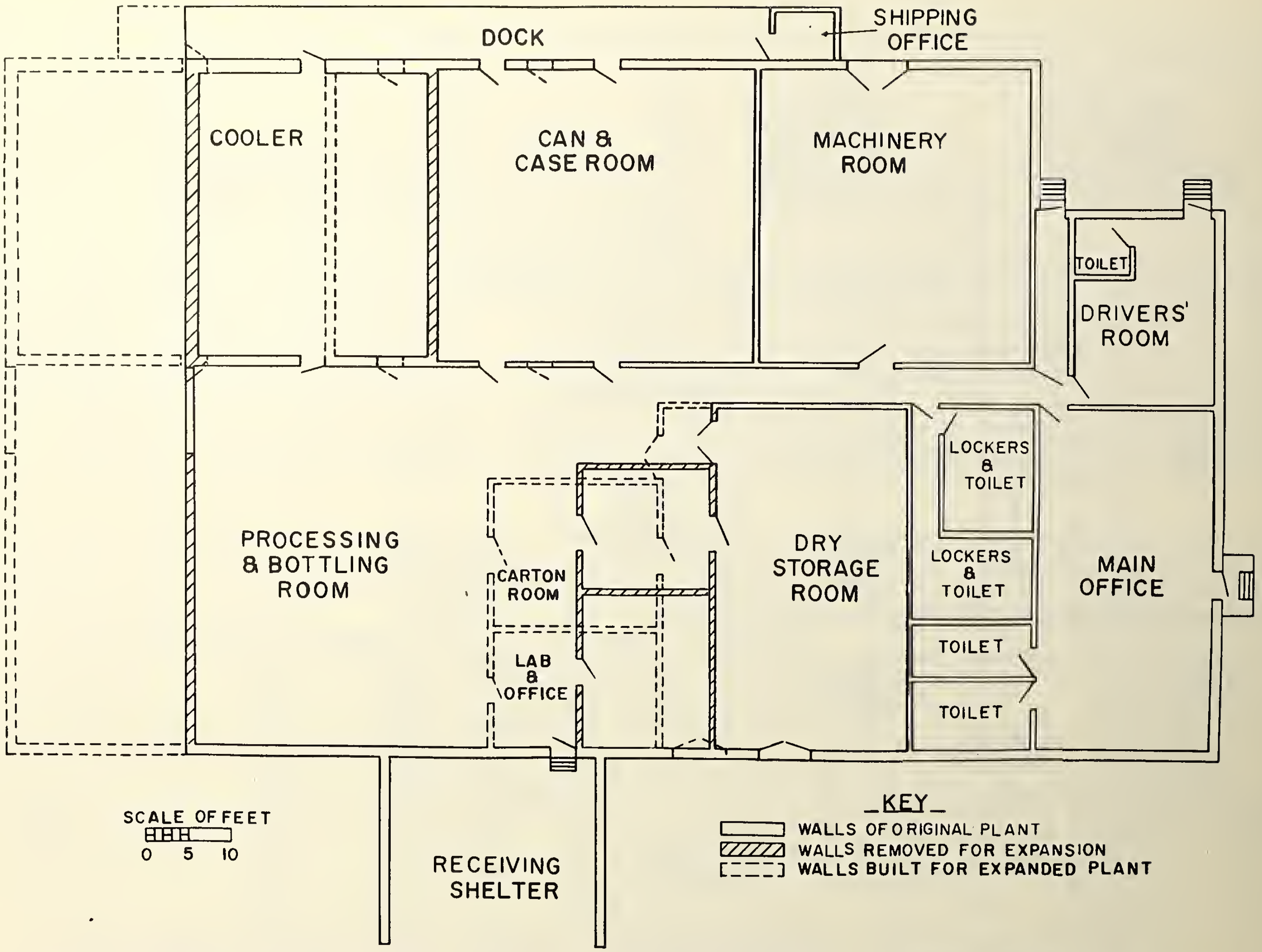

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Figure 39.—Proposed changes for expanding a 6,000-gallon-per-day plant to accommodate a daily volume of 10,000 gallons.

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and sizes of processing tanks required. Three additional tanks would be required, a 3,000-gallon surge tank, 300-gallon surge tank, and a 4,000-gallon milk storage tank. Other changes would include: The replacement of the 600-gallon buttermilk vat by a 1,000-gallon vat; the replacement of the 500-gallon chocolate tank by a 800-gallon tank; and the replacement of the 800-gallon skim milk tank by a 100-gallon tank. On the basis of the processing schedule for the 10,000-gallon-per-day plant, it is not necessary to store that skim milk which is used in the preparation of buttermilk in the skim milk tank. A 100-gallon tank, therefore, should be adequate for the storage of skim milk. The change in equipment requirements would necessitate a rearrangement of equipment to provide the most efficient flow of milk through the room.

The expansion of the cooler would be based entirely on the increased storage space requirements. The room would be increased in length by 9 feet, and would measure 35 feet 9 inches by 32 feet 6 inches. The expansion would be outward through the exterior wall, and in the same direction as the expansion of the processing and bottling room. The doorways in the cooler would be re-located to provide the most efficient location of aisles.

The expansion of the can and case room should be based on the increased storage requirements for cans and cases. The space requirements for equipment would not be changed. The enlarged room would be 48 feet 6 inches long by 33 feet 6 inches wide, an increase in length of 12 feet. The expansion would be in the previously described direction, and the interior wall between the cooler and the can and case room would be moved 12 feet into the original cooler area. The doorways in the room would be re-located to provide the best location of aisles.

The size of the dry storage room would be increased to 28 feet 4 inches by 39 feet 3 inches. The additional 6 feet 4 inches would be absorbed by expanding the room in the direction of the carton room. An additional carton rack would be required, and the racks would be rearranged to provide an efficient arrangement in the enlarged room. The receiving door would also be re-located to insure the most efficient flow of supplies into the plant.

On the basis of an increased number of empty cartons, the carton room would be increased in length by 5 feet and increased in width by 2 feet 6 inches. The enlarged room would measure 19 feet by 16 feet 6 inches. To provide an efficient arrangement the room housing the laboratory and manager's office would also be rearranged, providing an area 19 feet long by 13 feet wide. The walls of the two rooms would be moved in the direction of the processing and bottling room.

The layout and arrangement of the remaining area of the plant would not be effected by the increase in volume. In the event that additional space was required for the main office, consideration should be given to the construction of a second-floor office area.

APPENDIX

EQUIPMENT COSTS

In order to make comparisons between different types of equipment for performing the various cycles of operations in fluid milk plants, it was necessary to determine cost figures for each of the type of equipment included in the study. Costs per 1,000 gallons of milk for each type of equipment based on different annual volumes were determined (tables 27 and 28).

TABLE 27.—*Ownership and operating cost for milk-*

Equipment	Amount of equipment	Capacity	Initial cost [1]	Expected life
			Dollars	*Years*
Can receiving:				
Incoming gravity conveyor [7]	25 ft.	18 in. wide	200. 00	14
Incoming power conveyor [8]	25 ft.	18 in. wide	1, 500. 00	15
Dump bar [7]	1		10. 00	17
Cradle [8]	1		50. 00	15
Weigh tank [7] [8]	1	500 lb	2, 339. 00	17
Dial scale [7]	1	1,000 lb	1, 007. 00	22
Recording scale [8]	1	1,000 lb	1, 622. 00	20
Can washer [7]	1	7 cans/min	5, 690. 00	17
Can washer [8]	1	7 cans/min	5, 690. 00	17
Outgoing gravity conveyor [7] [8]	55 ft.	18 in. wide	500. 00	14
Receiving vat [7] [8]	1	1,000 lb	1, 095. 00	17
Positive pump [7]	1	19,000 lb./hr	1, 468. 00	15
Positive pump [8]	1	25,000 lb./hr	1, 541. 00	15
Plate cooler [7]	1	15,000 lb./hr	2, 600. 00	18
Plate cooler [8]	1	25,000 lb./hr	3, 630. 00	18
Piping and fittings [7] [8]	22 ft.	1½ in. I. D	144. 96	14
Raw milk storage tank [7] [8]	2	4,000 gal	13, 000. 00	20
Bulk receiving:				
Plastic drain hose [9] [10]	15 ft.	2 in. I. D	89. 55	3
Positive pump [10]	1	60,000 lb./hr	1, 311. 00	15
Piping and fittings [9] [10]	20 ft.	2 in. I. D	92. 85	14
Raw milk storage tank [9] [10]	2	4,000 gal	13, 000. 00	20
Processing:				
Standardizing clarifier [11]	1	6,000 lb./hr	4, 280. 00	14
Positive pump [11]	1	6,000 lb./hr	1, 190. 00	15
Standardizing clarifier [12]	1	12,000 lb./hr	5, 100. 00	14
Positive pump [12]	1	12,000 lb./hr	1, 600. 00	15
H. T. S. T. pasteurizer [11]	1	8,000 lb./hr	10, 000. 00	12
Positive pump [11]	1	8,000 lb/hr	1, 200. 00	15
H. T. S. T. pasteurizer [12]	1	8,000 lb./hr	10, 000. 00	12
Positive pump [12]	1	8,000 lb./hr	1, 200. 00	15
Homogenizer [11]	1	8,600 lb/hr	5, 255. 00	17
Homogenizer [12]	1	8,600 lb./hr	5, 255. 00	17
Surge tank [11] [12]	1	2,000 gal	4, 870. 00	20
Surge tank [11] [12]	1	300 gal	1, 840. 00	28
Separator [11] [12]	1	5,500 lb./hr	5, 700. 00	17
Positive pump [11] [12]	1	5,500 lb./hr	1, 360. 00	15
Chocolate tank [11] [12]	1	500 gal	965. 00	28
Skim milk tank [11] [12]	1	800 gal	1, 490. 00	28
Buttermilk vat [11] [12]	1	600 gal	4, 170. 00	15
Cream vat [11] [12]	1	100 gal	1, 255. 00	15
Centrifugal pump [11] [12]	1	10,000 lb./hr	220. 00	24
Piping and fittings [11] [12]	337 ft.	1½ in. I. D	4, 388. 00	14
Bottling:				
Case conveyor, glass [14]	140 ft.	18 in. wide	4, 385. 75	15
Case conveyor, paper [16]	140 ft.	18 in. wide	4, 385. 75	15
Case conveyor, paper [18]	140 ft.	18 in. wide	4, 385. 75	15
Case washer [20]	2	10 cases/min	5, 000. 00	12
Case washer [21]	1	10 cases/min	2, 500. 00	12
Bottle washer [20]	1	55 qt/min	7, 410. 00	16
Centrifugal pump [20]	2	10,000 lb./hr	440. 00	24
Centrifugal pump [21]	1	10,000 lb./hr	220. 00	24
Carton machine [20]	1	45 cartons/min	54, 500. 00	15
Carton machine [21]	1	75 cartons/min	95, 000. 00	15
Bottle filler and capper [20]	1	48 qt./min	6, 400. 00	17
Bottle conveyor [20]	20 ft.	4 in. wide	1, 674. 75	15
Packaging in cans:				
Can conveyor [22]	87 ft.	18 in. wide	3, 175. 00	15
Wash vat [24] [25]	1		325. 00	18
Can sterilizer [24]	1		105. 00	17
Can washer [25]	1		1, 615. 00	17
Centrifugal pump [24]	1	10,000 lb./hr	220. 00	24
Centrifugal pump [25]	1	10,000 lb./hr	220. 00	24
Can filling machine [24]	1		1, 450. 00	15
Filler valve [25]	1		360. 00	20

See footnotes at end of table.

handling equipment for a 6,000-gallon-per-day plant

Ownership cost				Operating cost			Total annual cost	Total annual volume [6]	Cost per 1,000 gallons
Depreciation	Interest [2]	Insurance and taxes [3]	Total	Power, fuel and water [4]	Maintenance [5]	Total			
Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Gallons*	*Dollars*
14. 29	5. 00	4. 00	23. 29	----------	5. 00	5. 00	28. 29	1, 872, 000	0. 0151
100. 00	37. 50	30. 00	167. 50	6. 74	20. 00	26. 74	194. 24	1, 872, 000	. 1038
. 59	. 25	. 20	1. 04	----------	----------	----------	1. 04	1, 872, 000	. 0006
3. 34	1. 25	1. 00	5. 59	----------	----------	----------	5. 59	1, 872, 000	. 0030
137. 59	58. 48	46. 78	242. 85	----------	----------	----------	242. 85	1, 872, 000	. 1297
45. 77	25. 18	20. 14	91. 09	----------	2. 00	2. 00	93. 09	1, 872, 000	. 0497
81. 10	40. 55	32. 44	154. 09	1. 35	4. 00	5. 35	159. 44	1, 872, 000	. 0852
334. 71	142. 25	113. 80	590. 76	761. 21	180. 00	941. 21	1, 531. 97	1, 872, 000	. 8184
334. 71	142. 25	113. 80	590. 76	464. 47	180. 00	644. 47	1, 235. 23	1, 872, 000	. 6598
35. 70	12. 50	10. 00	58. 20	----------	5. 00	5. 00	63. 20	1, 872, 000	. 0337
64. 41	27. 38	21. 90	113. 69	----------	----------	----------	113. 69	1, 872, 000	. 0607
97. 86	36. 70	29. 36	163. 92	16. 57	75. 00	91. 57	255. 49	1, 872, 000	. 1365
102. 73	38. 53	30. 82	172. 08	13. 48	75. 00	88. 48	260. 56	1, 872, 000	. 1392
144. 44	65. 00	52. 00	261. 44	115. 97	50. 00	165. 97	427. 41	1, 872, 000	. 2283
201. 67	90. 75	72. 60	365. 02	117. 26	50. 00	167. 26	532. 28	1, 872, 000	. 2843
10. 35	3. 62	2. 90	16. 87	----------	----------	----------	16. 87	1, 872, 000	. 0090
650. 00	325. 00	260. 00	1, 235. 00	299. 52	20. 00	319. 52	1, 554. 52	1, 872, 000	. 8304
29. 85	2. 24	1. 79	33. 88	----------	----------	----------	33. 88	1, 872, 000	. 0181
87. 40	32. 78	26. 22	146. 40	15. 91	100. 00	115. 91	262. 31	1, 872, 000	. 1401
6. 63	2. 32	1. 86	10. 81	----------	----------	----------	10. 81	1, 872, 000	. 0058
650. 00	325. 00	260. 00	1, 235. 00	299. 52	20. 00	319. 52	1, 554. 52	1, 872, 000	. 8304
305. 71	107. 00	85. 60	498. 31	65. 52	120. 00	185. 52	683. 83	1, 516, 320	. 4510
79. 33	29. 75	23. 80	132. 88	32. 76	75. 00	107. 76	240. 64	1, 516, 320	. 1587
364. 29	127. 50	102. 00	593. 79	56. 16	120. 00	176. 16	769. 95	1, 516, 320	. 5078
106. 67	40. 00	32. 00	178. 67	28. 08	75. 00	103. 08	281. 75	1, 516, 320	. 1858
833. 33	250. 00	200. 00	1, 283. 33	733. 82	170. 00	903. 82	2, 187. 15	1, 666, 080	1. 3128
80. 00	30. 00	24. 00	134. 00	35. 57	75. 00	110. 57	244. 57	1, 666, 080	. 1468
833. 33	250. 00	200. 00	1, 283. 33	638. 66	170. 00	808. 66	2, 091. 99	1, 666, 080	1. 2556
80. 00	30. 00	24. 00	134. 00	30. 89	75. 00	105. 89	239. 89	1, 666, 080	. 1440
309. 12	131. 38	105. 10	545. 60	553. 80	85. 00	638. 80	1, 184. 40	1, 553, 760	. 7623
309. 12	131. 38	105. 10	545. 60	477. 36	85. 00	562. 36	1, 107. 96	1, 553, 760	. 7131
243. 50	121. 75	97. 40	462. 65	19. 34	10. 00	29. 34	491. 99	1, 422, 720	. 3458
65. 71	46. 00	36. 80	148. 51	----------	25. 00	25. 00	173. 51	243, 360	. 7130
335. 29	142. 50	114. 00	591. 79	22. 46	40. 00	62. 46	654. 25	355, 680	1. 8394
90. 67	34. 00	27. 20	151. 87	5. 61	75. 00	80. 61	232. 48	355, 680	. 6536
34. 46	24. 13	19. 30	77. 89	16. 54	25. 00	41. 54	119. 43	131, 040	. 9114
53. 21	37. 25	29. 80	120. 26	27. 46	25. 00	52. 46	172. 72	205, 920	. 8388
278. 00	104. 25	83. 40	465. 65	423. 54	50. 00	473. 54	939. 19	187, 200	5. 0170
83. 67	31. 38	25. 10	140. 15	32. 32	30. 00	62. 32	202. 47	18, 720	10. 8157
9. 17	5. 50	4. 40	19. 07	8. 11	20. 00	28. 11	47. 18	336, 960	. 1400
313. 43	109. 70	87. 76	510. 89	----------	30. 00	30. 00	540. 89	2, 227, 680	[13] . 2428
292. 38	109. 64	87. 72	489. 74	74. 88	50. 00	124. 88	614. 62	----------	[15] . 8207
292. 38	109. 64	87. 72	489. 74	114. 19	50. 00	164. 19	653. 93	----------	[17] . 6872
292. 38	109. 64	87. 72	489. 74	103. 90	50. 00	153. 90	643. 64	----------	[19] . 4047
416. 66	125. 00	100. 00	641. 66	452. 40	60. 00	512. 40	1, 154. 06	1, 497, 600	. 7706
208. 33	62. 50	50. 00	320. 83	161. 62	30. 00	191. 62	512. 45	1, 497, 600	. 3422
463. 13	185. 25	148. 20	796. 58	671. 11	250. 00	921. 11	1, 717. 69	748, 800	2. 2939
18. 34	11. 00	8. 80	38. 14	39. 96	40. 00	79. 96	118. 10	1, 497, 600	. 0790
9. 17	5. 50	4. 40	19. 07	24. 04	20. 00	44. 04	63. 11	1, 497, 600	. 0421
3, 633. 33	1, 362. 50	1, 090. 00	6, 085. 83	304. 83	650. 00	954. 83	7, 040. 66	748, 800	9. 4026
6, 333. 33	2, 375. 00	1, 900, 00	10, 608. 33	518. 85	1, 300. 00	1, 818. 85	12, 427. 18	1, 497, 600	8. 2981
376. 47	160. 00	128. 00	664. 47	25. 37	250. 00	275. 37	939. 84	748, 800	1. 2551
111. 65	41. 87	33. 50	187. 02	4. 32	15. 00	19. 32	206. 34	748, 800	. 2756
211. 67	79. 38	63. 50	354. 55	31. 20	50. 00	81. 20	435. 75	----------	[23] 1. 1637
18. 06	8. 13	6. 50	32. 69	----------	----------	----------	32. 69	374, 400	. 0873
6. 18	2. 63	2. 10	10. 91	69. 17	50. 00	119. 17	130. 08	374, 400	. 3474
95. 00	40. 38	32. 30	167. 68	60. 69	150. 00	210. 69	378. 37	374, 400	1. 0106
9. 17	5. 50	4. 40	19. 07	8. 11	20. 00	28. 11	47. 18	374, 400	. 1260
9. 17	5. 50	4. 40	19. 07	5. 30	20. 00	25. 30	44. 37	374, 400	. 1185
96. 66	36. 25	29. 00	161. 91	1. 22	20. 00	21. 22	183. 13	374, 400	. 4891
18. 00	9. 00	7. 20	34. 20	----------	----------	----------	34. 20	374, 400	. 0913

TABLE 27.—*Ownership and operating cost for milk-handling*

Equipment	Amount of equipment	Capacity	Initial cost [1]	Expected life
			Dollars	*Years*
Storing and loading out:				
Case dolly [26]	148		2, 619. 60	15
Case dolly [28]	104		1, 840. 80	15
2-wheel case truck [26] [28]	1		60. 00	15
Cleaning equipment				
C. I. P. tank [30]	1	100 gal	200. 00	25
Centrifugal pump [30]	2	10,000 lb./hr	440. 00	24
Pipe wash vat [30] [31]	1		450. 00	15

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[1] Based on f. o. b. factory costs.

[2] Interest at 5 percent of average investment.

[3] Insurance and taxes at 2 percent of initial investment.

[4] Based on costs of 1 cent per kw.-hr. for power, 7 cents per therm for fuel, and .021 cent per gallon for water.

[5] Based on average costs in the industry in Georgia.

[6] Based on the annual volume of milk handled by each item of equipment.

[7] Items used with the gravity conveyor, dump bar, and dial scale method.

[8] Items used with the power conveyor, cradle dump, and recording scale method.

[9] Items used with the gravity-drain method.

[10] Items used with the pump-drain method.

[11] Items used with an unbalanced system of equipment.

[12] Items used with a balanced system of equipment.

[13] Piping cost allocated among processing operations on the basis of the volume handled in each operation.

[14] Used in the 3 following operations when milk is bottled in paper and glass: Receiving and handling empty cases, casing bottles of milk, and transporting cases of milk to cooler.

[15] Total cost determined on the basis of the hours of use and volume handled in each of the 3 operations in which the equipment is used. Cost allocations by operations: $0.3761 for receiving and handling empty cases, $0.2223 for transporting cases and cans of milk to cooler, and $0.2223 for casing glass bottles of milk.

[16] Used in the 4 following operations when milk is bottled in paper and glass: Receiving and handling empty cases, casing cartons of milk, transporting cases of milk to cooler, and transporting cases and cans of milk to dock.

[17] Total cost determined on the basis of the hours of use and volume handled in each of the 4 operations in which the equipment is used. Cost allocation by operations: $0.2629 for receiving and handling empty cases, $0.1502 for casing cartons of milk, $0.1502 for transporting cases of milk to cooler, and $0.1239 for transporting cases and cans of milk to dock.

equipment for a 6,000-gallon-per-day plant—Continued

Ownership cost				Operating cost			Total annual cost	Total annual volume [6]	Cost per 1,000 gallons
Depreciation	Interest [2]	Insurance and taxes [3]	Total	Power, fuel and water [4]	Maintenance [5]	Total			
Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Gallons*	*Dollars*
174. 64	65. 49	52. 39	292. 52	----------	740. 00	740. 00	1, 032. 52	1, 497, 600	[27] 0. 6894
122. 72	46. 02	36. 82	205. 56	----------	520. 00	520. 00	725. 56	1, 497, 600	[20] . 4845
4. 00	1. 50	1. 20	6. 70	----------	4. 00	4. 00	10. 70	1, 497, 600	. 0071
8. 00	5. 00	4. 00	17. 00	----------	5. 00	5. 00	22. 00	1, 872, 000	. 0118
18. 34	11. 00	8. 80	38. 14	27. 46	40. 00	67. 46	105. 60	1, 872, 000	. 0564
30. 00	11. 25	9. 00	50. 25	. 39	5. 00	5. 39	55. 64	1, 872, 000	. 0297

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[18] Used in the 4 following operations when milk is bottled in paper only: Receiving and handling empty cases, casing cartons of milk, transporting cases of milk to cooler, and transporting cases and cans of milk to dock.

[19] Total cost determined on the basis of the hours of use and volume handled in each of the 4 operations in which the equipment is used. Cost allocations by operations: $0.1022 for receiving and handling empty cases, $0.1022 for casing cartons of milk, $0.1022 for transporting cases of milk to cooler, and $0.0981 for transporting cases and cans of milk to dock.

[20] Items used when milk is bottled in paper and glass.

[21] Items used when milk is bottled in paper only.

[22] Used in the 4 following operations when milk is packaged in cans by the can washer, conveyor, and filler valve method: Receiving empty cans, transporting empty cans to filler, filling and sealing cans, and transporting cans of milk to cooler.

[23] Total cost determined on the basis of the hours of use and the volume handled in each of the 4 operations in which the equipment is used. Cost allocation by operations: $0.8670 for receiving empty cans, $0.0989 for transporting empty cans to filler, $0.0989 for filling and sealing cans, and $0.0989 for transporting cans of milk to cooler.

[24] Items used with the wash vat and filling machine method.

[25] Items used with the can washer, conveyor, and filler valve method.

[26] Items used in storing and loading out cases of milk bottled in paper and glass.

[27] Cost allocation by operations: Storing cases of milk by the case dolly method, $0.3447, and loading out cases of milk by the case dolly method, $0.3447.

[28] Items used in storing and loading out cases of milk bottled in paper.

[29] Cost allocations by operations: Storing cases of milk by the case dolly method, $0.2423, and loading out cases of milk by the case dolly method, $0.2423.

[30] Items used for cleaning pipe by the cleaned-in-place method.

[31] Item used for cleaning pipe by the take-down method.

TABLE 28.—*Ownership and operating cost for milk-*

Equipment	Amount of equipment	Capacity	Initial cost [1]	Expected life
Can receiving:			*Dollars*	*Years*
Incoming gravity conveyor [7]	25 ft.	18 in. wide	200. 00	12
Incoming power conveyor [8]	25 ft.	18 in. wide	1, 500. 00	13
Dump bar [7]	1		10. 00	14
Cradle [8]	1		50. 00	13
Weigh tank [7,8]	1	500 lb	2, 339. 00	14
Dial scale [7]	1	1,000 lb	1, 007. 00	19
Recording scale [8]	1	1,000 lb	1, 622. 00	17
Can washer [7]	1	7 cans/min	5, 690. 00	14
Can washer [8]	1	7 cans/min	5, 690. 00	14
Outgoing gravity conveyor [7,8]	55 ft.	18 in. wide	500. 00	12
Receiving vat [7,8]	1	1,000 lb	1, 095. 00	14
Positive pump [7]	1	19,000 lb./hr	1, 468. 00	13
Positive pump [8]	1	25,000 lb./hr	1, 541. 00	13
Plate cooler [7]	1	15,000 lb./hr	2, 600. 00	15
Plate cooler [8]	1	25,000 lb./hr	3, 630. 00	15
Piping and fittings [7,8]	22 ft.	1½ in. I. D	144. 96	12
Raw milk storage tank [7,8]	3	4,000 gal	19, 500. 00	17
Bulk receiving:				
Plastic drain hose [9,10]	15 ft.	2 in. I. D	89. 55	2
Positive pump [10]	1	60,000 lb./hr	1, 311. 00	13
Piping and fittings [9,10]	20 ft.	2 in. I. D	92. 85	12
Raw milk storage tank [9,10]	3	4,000 gal	19, 500. 00	17
Processing:				
Standardizing clarifier [11]	1	6,000 lb./hr	4, 280. 00	12
Positive pump [11]	1	6,000 lb./hr	1, 190. 00	13
Standardizing clarifier [12]	1	12,000 lb./hr	5, 100. 00	12
Positive pump [12]	1	12,000 lb./hr	1, 600. 00	13
H.T.S.T. pasteurizer [11]	1	8,000 lb./hr	10, 000. 00	10
Positive pump [11]	1	8,000 lb./hr	1, 200. 00	13
H.T.S.T. pasteurizer [12]	1	8,000 lb./hr	10, 000. 00	10
Positive pump [12]	1	8,000 lb./hr	1, 200. 00	13
Homogenizer [11]	1	8,600 lb./hr	5, 255. 00	14
Homogenizer [12]	1	8,600 lb./hr	5, 255. 00	14
Surge tank [11,12]	1	2,000 gal	4, 870. 00	17
Surge tank [11,12]	1	3,000 gal	5, 715. 00	17
Surge tank [11,12]	2	300 gal	3, 680. 00	24
Separator [11,12]	1	5,500 lb./hr	5, 700. 00	14
Positive pump [11,12]	1	5,500 lb./hr	1, 360. 00	13
Chocolate tank [11,12]	1	800 gal	1, 490. 00	24
Skim milk tank [11,12]	1	100 gal	560. 00	24
Buttermilk vat [11,12]	1	1,000 gal	5, 570. 00	13
Cream vat [11,12]	1	100 gal	1, 255. 00	13
Centrifugal pump [11,12]	1	10,000 lb./hr	220. 00	21
Piping and fittings [11,12]	379 ft.	1½ in. I. D	5, 556. 80	12
Bottling:				
Case conveyor—glass [14]	160 ft.	18 in. wide	4, 820. 00	13
Case conveyor—paper [16]	160 ft.	18 in. wide	4, 820. 00	13
Case conveyor—paper [18]	160 ft.	18 in. wide	4, 820. 00	13
Case washer [20]	2	10 cases/min	5, 000. 00	10
Case washer [21]	1	10 cases/min	2, 500. 00	10
Bottle washer [20]	1	48 qt./min	7, 410. 00	13
Centrifugal pump [20]	1	10,000 lb./hr	220. 00	21
Centrifugal pump [20]	1	10,000 lb./hr	220. 00	21
Centrifugal pump [21]	1	10,000 lb./hr	220. 00	21
Carton machine [21]	1	45 cartons/min	54, 500. 00	13
Carton machine [25]	1	75 cartons/min	95, 000. 00	13
Bottle filler and capper [20]	1	48 qt./min	6, 400. 00	14
Bottle conveyor [20]	30 ft.	4 in. wide	2, 185. 00	13
Packaging in cans:				
Can conveyor [22]	90 ft.	18 in. wide	3, 250. 00	13
Wash vat [24,25]	1		325. 00	15
Can sterilizer [24]	1		105. 00	14
Can washer [25]	1		1, 615. 00	14
Centrifugal pump [24]	1	10,000 lb./hr	220. 00	21
Centrifugal pump [25]	1	10,000 lb./hr	220. 00	21

See footnotes at end of table.

handling equipment for a 10,000-gallon-per-day plant

Ownership cost				Operating cost			Total annual cost	Total annual volume [6]	Cost per 1,000 gallons
Depreciation	Interest [2]	Insurance and taxes [3]	Total	Power, fuel and water [4]	Maintenance [5]	Total			
Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Gallons*	*Dollars*
16. 67	5. 00	4. 00	25. 67	----------	8. 50	8. 50	34. 17	3, 120, 000	0. 0110
115. 38	37. 50	30. 00	182. 88	11. 23	35. 00	46. 23	229. 11	3, 120, 000	. 0734
. 71	. 25	. 20	1. 16	----------	----------	----------	1. 16	3, 120, 000	. 0004
3. 85	1. 25	1. 00	6. 10	----------	----------	----------	6. 10	3, 120, 000	. 0020
167. 07	58. 48	46. 78	272. 33	----------	----------	----------	272. 33	3, 120, 000	. 0873
53. 00	25. 18	20. 14	98. 32	----------	3. 50	3. 50	101. 82	3, 120, 000	. 0326
95. 41	40. 55	32. 44	168. 40	2. 25	6. 50	8. 75	177. 15	3, 120, 000	. 0568
406. 43	142. 25	113. 80	662. 48	1, 268. 71	300. 00	1, 568. 71	2, 231. 19	3, 120, 000	. 7151
406. 43	142. 25	113. 80	662. 48	774. 13	300. 00	1, 074. 13	1, 736. 61	3, 120, 000	. 5566
41. 67	12. 50	10. 00	64. 17	----------	8. 50	8. 50	72. 67	3, 120, 000	. 0233
78. 21	27. 38	21. 90	127. 49	----------	----------	----------	127. 49	3, 120, 000	. 0409
112. 92	36. 70	29. 36	178. 98	27. 62	125. 00	152. 62	331. 60	3, 120, 000	. 1063
118. 54	38. 53	30. 82	187. 89	22. 47	125. 00	147. 47	335. 36	3, 120, 000	. 1075
173. 33	65. 00	52. 00	290. 33	193. 29	85. 00	278. 29	568. 62	3, 120, 000	. 1823
242. 00	90. 75	72. 60	405. 35	195. 44	85. 00	280. 44	685. 79	3, 120, 000	. 2198
12. 08	3. 62	2. 90	18. 60	----------	----------	----------	18. 60	3, 120, 000	. 0060
1, 147. 05	487. 50	390. 00	2, 024. 55	499. 21	49. 50	548. 71	2, 573. 26	3, 120, 000	. 8248
44. 78	2. 24	1. 79	48. 81	----------	----------	----------	48. 81	3, 120, 000	. 0156
100. 84	32. 78	26. 22	159. 84	26. 52	170. 00	196. 52	356. 36	3, 120, 000	. 1142
7. 74	2. 32	1. 86	11. 92	----------	----------	----------	11. 92	3, 120, 000	. 0038
1, 147. 05	487. 50	390. 00	2, 024. 55	499. 21	49. 50	548. 71	2, 573. 26	3, 120, 000	. 8248
356. 67	107. 00	85. 60	549. 27	108. 58	200. 00	308. 58	857. 85	2, 527, 200	. 3394
91, 54	29. 75	23. 80	145. 09	54. 29	125. 00	179. 29	324. 38	2, 527, 200	. 1284
425. 00	127. 50	102. 00	654. 50	93. 60	200. 00	293. 60	948. 10	2, 527, 200	. 3752
123. 08	40. 00	32. 00	195. 08	46. 80	125. 00	171. 80	366. 88	2, 527, 200	. 1452
1, 000. 00	250. 00	200. 00	1, 450. 00	1, 217. 42	285. 00	1, 502. 42	2, 952. 42	2, 776, 800	1. 0632
92. 31	30. 00	24. 00	146. 31	58. 97	125. 00	183. 97	330. 28	2, 776, 800	. 1189
1, 000. 00	250. 00	200. 00	1, 450. 00	1, 050. 82	285. 00	1, 335. 82	2, 785. 82	2, 776, 800	1. 0032
92. 31	30. 00	24. 00	146. 31	51. 17	125. 00	176. 17	322. 48	2, 776, 800	. 1161
375. 36	131. 38	105. 10	611. 84	920. 40	140. 00	1, 060. 40	1, 672. 24	2, 589, 600	. 6458
375. 36	131. 38	105. 10	611. 84	795. 60	140. 00	935. 60	1, 547. 44	2, 589, 600	. 5976
286. 47	121. 75	97. 40	505. 62	36. 50	15. 00	51. 50	557. 12	948, 480	. 5874
336. 18	142. 88	114. 30	593. 36	36. 50	15. 00	51. 50	644. 86	1, 422, 720	. 4533
153. 34	92. 00	73. 60	318. 94	----------	80. 00	80. 00	398. 94	405, 600	. 9836
407. 14	142. 50	114. 00	663. 64	37. 44	65. 00	102. 44	766. 08	592, 800	1. 2923
104. 62	34. 00	27. 20	165. 82	9. 36	125. 00	134. 36	300. 18	592, 800	. 5064
62. 08	37. 25	29. 80	129. 13	15. 60	40. 00	55. 60	184. 73	218, 400	. 8458
23. 33	14. 00	11. 20	48. 53	17. 16	40. 00	57. 16	105. 69	31, 200	3. 3875
428. 46	139. 25	111. 40	679. 11	656. 60	85. 00	741. 60	1, 420. 71	312, 000	4. 5536
96. 54	31. 38	25. 10	153. 02	49. 92	50. 00	99. 92	252. 94	31, 200	8. 1070
10. 48	5. 50	4. 40	20. 38	3. 12	35. 00	38. 12	58. 50	249, 600	. 2344
463. 07	138. 92	111. 14	713. 13	----------	50. 00	50. 00	763. 13	3, 712, 800	[13]. 2055
370. 77	120. 50	96. 40	587. 67	101. 09	85. 00	186. 09	773. 76	----------	[15] . 6200
370. 77	120. 50	96. 40	587. 67	165. 67	85. 00	260. 67	838. 34	----------	[17] . 5129
370. 77	120. 50	96. 40	587. 67	167. 54	85. 00	252. 54	840. 21	----------	[19] . 3165
500. 00	125. 00	100. 00	725. 00	694. 51	100. 00	794. 51	1, 519. 51	2, 496, 000	. 6088
250. 00	62. 50	50. 00	362. 50	161. 62	50. 00	211. 62	574. 12	2, 496, 000	. 2300
570. 00	185. 25	148. 20	903. 45	2, 230. 80	420. 00	2, 650. 80	3, 554. 25	1, 248, 000	2. 8480
10. 48	5. 50	4. 40	20. 38	33. 38	35. 00	68. 38	88. 76	1, 248, 000	. 0711
10. 48	5. 50	4. 40	20. 38	33. 70	35. 00	68. 70	89. 08	1, 248, 000	. 0714
10. 48	5. 50	4. 40	20. 38	26. 83	35. 00	61. 83	82. 21	2, 496, 000	. 0329
4, 192. 30	1, 362. 50	1, 090. 00	6, 644. 80	459. 27	1, 075. 00	1, 534. 27	8, 179. 07	1, 248, 000	6. 5537
7, 307. 69	2, 375. 00	1, 900. 00	11, 582. 69	868. 92	2, 150. 00	3, 018. 92	14, 601. 61	2, 496, 000	5. 8500
457. 14	160. 00	128. 00	745. 14	42. 12	420. 00	462. 12	1, 207. 26	1, 248, 000	. 9674
168. 08	54. 63	43. 70	266. 41	11. 23	25. 00	36. 23	302. 64	1, 248, 000	. 2425
250. 00	81. 25	65. 00	396. 25	31. 20	85. 00	116. 20	512. 45	----------	[23] . 8212
21. 67	8. 13	6. 50	36. 30	----------	----------	----------	36. 30	624, 000	. 0582
7. 50	2. 63	2. 10	12. 23	58. 03	85. 00	143. 03	155. 26	624, 000	. 2488
115. 36	40. 38	32. 30	188. 04	93. 29	250. 00	343. 29	531. 33	624, 000	. 8515
10. 48	5. 50	4. 40	20. 38	13. 73	35. 00	48. 73	69. 11	624, 000	. 1108
10. 48	5. 50	4. 40	20. 38	8. 74	35. 00	43. 74	64. 12	624, 000	. 1028

TABLE 28.—*Ownership and operating cost for milk-handling*

Equipment	Amount of equipment	Capacity	Initial cost [1]	Expected life
			Dollars	*Years*
Packaging in cans—Continued				
Can filling machine [24]	1		1, 450. 00	13
Filler valve [25]	1		360. 00	17
Storing and loading out:				
Case dolly [26]	243		4, 301. 10	13
Case dolly [28]	174		3, 079. 80	13
2-wheel case truck [26] [28]	1		60. 00	13
Cleaning equipment:				
C. I. P. tank [30]	1	100 gal	200. 00	22
Centrifugal pump [30]	2	10,000 lb./hr	440. 00	21
Pipe wash vat [30] [31]	1		450. 00	13

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[1] Based on f. o. b. factory costs.

[2] Interest at 5 percent of average investment.

[3] Insurance and taxes at 2 percent of initial investment.

[4] Based on costs of 1 cent per kw.-hr. for power, 7 cents per therm for fuel, and .021 cent per gallon for water.

[5] Based on average costs in the industry in Georgia.

[6] Based on the annual volume of milk handled by each item of equipment.

[7] Items used with the gravity conveyor, dump bar, and dial scale method.

[8] Items used with the power conveyor, cradle dump, and recording scale method.

[9] Items used with the gravity-drain method.

[10] Items used with the pump drain method.

[11] Items used with an unbalanced system of equipment.

[12] Items used with a balanced system of equipment.

[13] Piping cost allocated among processing operations on the basis of volume handled in each operation.

[14] Used in the 3 following operations when milk is bottled in paper and glass: Receiving and handling empty cases, casing bottles of milk, and transporting cases of milk to cooler.

[15] Total cost determined on the basis of the hours of use and volume handled in each of the 3 operations in which the equipment is used. Cost allocation by operations: \$0.2067 for receiving and handling empty cases, \$0.2067 for casing glass bottles of milk, and \$0.2067 for transporting cases of milk to cooler.

[16] Used in the 4 following operations when milk is bottled in paper and glass: Receiving and handling empty cases, casing cartons of milk, transporting cases of milk to cooler, and transporting cases and cans of milk to dock.

[17] Total cost determined on the basis of the hours of use and volume handled in each of the 4 operations in which the equipment is used. Cost allocation by operations: \$0.1355 for receiving and handling empty cases, \$0.1355 for casing cartons of milk, \$0.1355 for transporting cases of milk to cooler, and \$0.1064 for transporting cases and cans of milk to dock.

equipment for a 10,000-gallon-per-day plant—Continued

Ownership cost				Operating cost			Total annual cost	Total annual volume [6]	Cost per 1,000 gallons
Depreciation	Interest [2]	Insurance and taxes [3]	Total	Power, fuel and water [4]	Maintenance [5]	Total			
Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Gallons*	*Dollars*
111.54	36.25	29.00	176.79	2.09	35.00	37.09	213.88	624,000	0.3428
21.18	9.00	7.20	37.38	----------	----------	----------	37.38	624,000	.0599
330.85	107.53	86.02	524.40	----------	1,215.00	1,215.00	1,739.40	2,496,000	[27] .6969
236.91	77.00	61.60	375.51	----------	870.00	870.00	1,245.51	2,496,000	[29] .4990
4.62	1.50	1.20	7.32	----------	6.50	6.50	13.82	2,496,000	.0055
9.09	5.00	4.00	18.09	----------	8.50	8.50	26.59	3,120,000	.0085
20.96	11.00	8.80	40.76	26.20	70.00	96.20	136.96	3,120,000	.0439
34.62	11.25	9.00	54.87	.39	8.50	8.89	63.76	3,120,000	.0204

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[18] Used in the 4 following operations when milk is bottled in paper only: Receiving and handling empty cases, casing cartons of milk, transporting cases of milk to cooler, and transporting cases and cans of milk to dock.

[19] Total cost determined on the basis of the hours of use and volume handled in each of the 4 operations in which the equipment is used. Cost allocation by operations: $0.0800 for receiving and handling empty cases, $0.0800 for casing cartons of milk, $0.0800 for transporting cases of milk to cooler, and $0.0765 for transporting cases and cans of milk to dock.

[20] Items used when milk is bottled in paper and glass.

[21] Items used when milk is bottled in paper only.

[22] Used in the 4 following operations when milk is packaged in cans by the can washer, conveyor, and filler valve method: Receiving empty cans, transporting empty cans to filler, filling and sealing cans, and transporting cans of milk to cooler.

[23] Total cost determined on the basis of the hours of use and the volume handled in each of the 4 operations in which the equipment is used. Cost allocation by operations: $0.4813 for receiving empty cans, $0.1133 for transporting empty cans to filler, $0.1133 for filling and sealing cans, and $0.1133 for transporting cans of milk to cooler.

[24] Items used with the wash vat and filling machine method.

[25] Items used with the can washer, conveyor, and filler valve method.

[25] Items used in storing and loading out cases of milk bottled in paper and glass.

[27] Cost allocations by operations: Storing cases of milk by the case dolly method, $0.3485, and loading out cases of milk by the case dolly method, $0.3485.

[28] Items used in storing and loading out cases of milk bottled in paper.

[29] Cost allocations by operations: Storing cases of milk by the case dolly method, $0.2495, and loading out cases of milk by the case dolly method, $0.2495.

[30] Items used for cleaning pipe by the cleaned-in-place method.

[31] Items used for cleaning pipe by the take-down method.

TABLE 29.—*Fatigue and personal allowances for performing various handling operations in fluid milk plants*

Time item	Allowances		
	Fatigue	Personal	Total
	Percent	*Percent*	*Percent*
Position cans by pushing along conveyor to dumping device	15	5	20
Remove lids from cans and place in can washer rack	5	5	10
Pour milk with dump bar	20	5	25
Pour milk with cradle	15	5	20
Place empty cans on track of can washer	10	5	15
Sample milk from weigh tank with dipper	5	5	10
Observe weights of milk on dial scale and record basic data	5	5	10
Stamp weights of milk by actuating scale recording device, record other data	5	5	10
Position bulk tank truck and check milk	10	5	15
Connect drain hose to bulk tank truck	10	5	15
Disconnect drain hose from bulk tank truck	10	5	15
Wash bulk tank	15	5	20
Remove bulk tank truck from receiving shelter	5	5	10
Remove two dispenser cans from conveyor, haul 4 feet, and return	10	5	15
Wash dispenser cans and lids manually in vat, and stack can	10	5	15
Wash dispenser cans in can washer, and wash lids manually in vat	10	5	15
Sanitize dispenser cans and lids by rinsing in chemical bactericide	10	5	15
Haul two empty dispenser cans 20 feet from can washing area to can filling area and return	10	5	15
Fill dispenser cans with can filling machine	10	5	15
Fill dispenser cans with filler valve	5	5	10
Seal dispenser cans with lead-type seal	10	5	15
Seal dispenser cans with clasp	5	5	10
Place full dispenser cans on case conveyor	15	5	20
Transport 10 cases from stacks to conveyor by case dolly and return	15	5	20
Stack empty dollies beside conveyor	10	5	15
Position 2-wheel case truck to pick up stack of cases	10	5	15
Pick up stack of 5 full cases	15	5	20
Transport 5 cases from stacks to conveyor by 2-wheel case truck and return	15	5	20
Set down stack of 5 full cases	15	5	20
Load cases from stack to conveyor	15	5	20
Load full dispenser cans from stack to conveyor	15	5	20
Disassemble, scrub, rinse, and reassemble all items of milk-handling equipment	10	5	15

TABLE 30.—*Labor requirements per 1,000 gallons for receiving milk in cans and receiving milk in bulk for a 6,000-gallon-per-day plant*

Time item	Base time	Fatigue and personal allowances	Productive time
	Man-hours	*Man-hours*	*Man-hours*
Receiving milk in cans:			
Position cans by pushing along conveyor to dumping device (3 to 4 feet)	0. 10	0. 02	0. 12
Remove lids from cans and place in can washer rack	. 06	. 01	. 07
Pour milk with dump bar	. 11	. 03	. 14
Place empty cans on track of washer	. 04	. 01	. 05
Sample milk from weigh tank with dipper	. 05	. 01	. 06
Observe weight of milk on dial scale and record basic data	. 14	. 01	. 15
Remove lids from cans and place in can washer rack	. 06	. 01	. 07
Pour milk with cradle	. 08	. 02	. 10
Place empty can on track of washer	. 04	. 01	. 05
Sample milk from weigh tank with dipper	. 05	. 01	. 06
Stamp weight of milk by actuating scale recording device and record data	. 07	. 01	. 08
Receiving milk in bulk:			
Position tank truck and check milk	. 01	0	. 01
Connect drain hose to truck tank	. 01	0	. 01
Disconnect drain hose from truck tank	. 004	0	. 004
Wash truck tank	. 03	0	. 03
Remove truck tank from receiving shelter	. 001	0	. 001

TABLE 31.—*Labor requirements per 1,000 gallons for a 6,000-gallon plant for packaging milk in cans by the wash vat and filling machine method and the can washer, conveyor, and filler valve method*

Time item	Base time	Fatigue and personal allowances	Productive time
Wash vat and filling machine method			
Receiving cans: Remove 2 empty dispenser cans from conveyor, haul 5 feet, stack and return	*Man-hours* 0. 18	*Man-hours* 0. 03	*Man-hours* 0. 21
Washing cans manually:			
Remove lid and parchment paper from can	. 69	. 10	. 79
Place lid on rack	. 09	. 01	. 10
Carry 4 lids 15 feet to wash vat	. 02	0	. 02
Scrub lid with steel pad	. 97	. 15	1. 12
Place lid in rinsing compartment	. 08	. 01	. 09
Walk 15 feet to dirty cans	. 02	0	. 02
Remove dirty can from stack and carry 15 feet to wash vat	. 21	. 03	. 24
Remove drain hose from can	. 18	. 03	. 21
Scrub can with steel pad	1. 53	. 23	1. 76
Drain can and move 3 feet to rinsing compartment	. 17	. 03	. 20
Rinse can and place on sterilizer	. 39	. 06	. 45
Steam can while attaching drain hose	. 68	. 10	. 78
Turn can right-side up	. 11	. 02	. 13
Replace lid on can	. 12	. 02	. 14
Carry can 7 feet to rack	. 07	. 01	. 08
Stack can	. 10	. 02	. 12
Total	5. 43	. 82	6. 25
Sanitizing cans: Sanitize dispenser cans and lids by rinsing in chemical bactericide	. 73	. 11	. 84
Transporting cans to filler: Haul 2 empty dispenser cans 20 feet from can washing area to filling area and return	. 37	. 05	. 42
Filling and sealing cans:			
Place can on filler platform and raise platform	. 17	. 03	. 20
Fill can	. 43	. 06	. 49
Lower platform	. 13	. 02	. 15
Place full can on floor	. 13	. 02	. 15
Place parchment paper and lid on can	. 28	. 04	. 32
Move can 2 feet to sealing position	. 18	. 03	. 21
Place 2 sealing wires and identification ticket on can	. 10	. 01	. 11
Seal can with lead type seal	1. 63	. 24	1. 87
Place can on case conveyor	. 11	. 02	. 13
Total	3. 16	. 47	3. 63
Can washer, conveyor, and filler valve method			
Receiving cans: Remove 2 empty dispenser cans from conveyor, haul 5 feet, stack and return	. 18	. 03	. 21
Washing cans with a can washer:			
Remove lid and parchment paper from can	. 69	. 10	. 79
Place lid on rack	. 09	. 01	. 10
Carry 4 lids 15 feet to wash vat	. 02	0	. 02
Scrub lid with steel pad	. 97	. 15	1. 12
Place lid in rinsing compartment	. 08	. 01	. 09
Walk 15 feet to dirty cans	. 02	0	. 02
Remove dirty can from stack and carry 15 feet to can washer	. 21	. 03	. 24
Remove drain hose from can	. 18	. 03	. 21
Place can in washer	. 22	. 03	. 25
Close washer lid, wash can, and open lid	. 42	. 06	. 48
Remove can from washer	. 17	. 03	. 20
Carry can 7 feet and place on steam platform	. 22	. 03	. 25
Rinse and steam can while attaching drain hose	. 68	. 10	. 78
Turn can right-side up	. 11	. 02	. 13
Replace lid on can	. 12	. 02	. 14
Carry can 7 feet to rack	. 07	. 01	. 08
Stack can	. 10	. 02	. 12
Total	4. 37	. 65	5. 02
Sanitizing cans: Sanitize dispenser cans and lids by rinsing in chemical bactericide	. 73	. 11	. 84
Filling and sealing cans:			
Position can under filling tube	. 22	. 02	. 24
Lower tube, fill can, and raise tube	. 75	. 08	. 83
Seal can with clasp	1. 25	. 13	1. 38
Total	2. 22	. 23	2. 45

TABLE 32.—*Labor requirements per 1,000 gallons for a 6,000-gallon-per-day plant for loading out cases of milk bottled in paper and glass with case dollies, and manually loading out milk packaged in cans*

Time item	Base time	Fatigue and personal allowance	Productive time
Milk bottled in paper:			
Transport cases to conveyor and return:[1]	*Man-hours*	*Man-hours*	*Man-hours*
5 feet	0.04	0.01	0.05
10 feet	.06	.01	.07
15 feet	.08	.02	.10
20 feet	.09	.02	.11
Transfer cases from dolly to conveyor	.14	.03	.17
Stack empty dollies beside conveyor	.01	0	.01
Milk bottled in glass:			
Transport cases to conveyor and return:[2]			
5 feet	.07	.01	.08
10 feet	.10	.02	.12
15 feet	.13	.03	.16
20 feet	.16	.03	.19
Transfer cases from dolly to conveyor	.28	.06	.34
Stack empty dollies beside conveyor	.02	0	.02
Milk packaged in cans: Move cans from stacks onto conveyor (4 feet)	.20	.04	.24

[1] Based on 2 stacks of 5 cases. For transport times at additional distances use formula $t=0.0209+0.0037d$ when d=distance between points in feet, and t=base time in man-hours per 1,000 gallons to include transport loaded and return.

[2] Based on 2 stacks of 5 cases. For transport times at additional distances use formula $t=0.0368+0.0064d$ when d=distance between points in feet, and t=base time in man-hours per 1,000 gallons to include transport loaded and return.

TABLE 33.—*Labor requirements per 1,000 gallons for a 6,000-gallon-per-day plant for loading out cases of milk bottled in paper and glass with 2-wheel case truck, and manually loading out milk packaged in cans*

Time item	Base time	Fatigue and personal allowances	Productive time
Milk bottled in paper:	*Man-hours*	*Man-hours*	*Man-hours*
Position 2-wheel case truck to pick up stack	0.13	0.02	0.15
Pick up stacks of 5 full cases	.08	.01	.09
Transport cases to conveyor and return:[1]			
5 feet	.10	.02	.12
10 feet	.13	.03	.16
15 feet	.16	.03	.19
20 feet	.19	.04	.23
Set down stack of 5 full cases	.03	.01	.04
Transfer cases from stack to conveyor	.14	.03	.17
Milk bottled in glass:			
Position 2-wheel case truck to pick up stack	.23	.04	.27
Pick up stacks of 5 full cases	.13	.02	.15
Transport cases to conveyor and return:[2]			
5 feet	.18	.03	.21
10 feet	.23	.04	.27
15 feet	.28	.06	.34
20 feet	.33	.07	.40
Set down stack of 5 full cases	.06	.01	.07
Transfer cases from stack to conveyor	.28	.06	.34
Milk packaged in cans: Move dispenser cans from stack onto conveyor (4 feet)	.20	.04	.24

[1] Based on stacks of 5 cases. For transport times at additional distances use formula $t=0.0684+0.0060d$ when d=distance between points in feet, and t=base time in man-hours per 1,000 gallons to include transport empty and transport loaded.

[2] Based on stacks of 5 cases. For transport times at additional distances use formula $t=0.1205+0.0106d$ when d=distance between points in feet, and t=base time in man-hours per 1,000 gallons to include transport empty and transport loaded.

Table 34.—*Labor requirement per 1,000 gallons for cleaning milk-handling equipment in a fluid milk plant with a daily volume of 6,000 gallons*

Time item	Base time	Fatigue and personal allowance	Productive time
Clean:	*Man-hours*	*Man-hours*	*Man-hours*
500-pound weigh tank	0. 03	0. 01	0. 04
1,000-pound receiving vat	. 03	0	. 03
4,000-gallon storage tank	. 04	. 01	. 05
300-gallon surge tank	. 04	. 01	. 05
500-gallon chocolate tank	. 03	. 01	. 04
800-gallon skim milk tank	. 07	. 01	. 08
100-gallon cream vat	. 04	. 01	. 05
25,000-pound-per-hour plate cooler	. 01	0	. 01
12,000-pound-per-hour standardizing clarifier	. 15	. 02	. 17
8,000-pound-per-hour pasteurizer	. 02	0	. 02
8,600-pound-per-hour homogenizer	. 10	. 01	. 11
5,500-pound-per-hour separator	. 15	. 02	. 17
45-carton-per-minute carton machine	. 13	. 02	. 15
75-carton-per-minute carton machine	. 24	. 04	. 28
48-quart-per-minute bottle filler	. 13	. 02	. 15
Can filler valve and tank	. 03	0	. 03
5,500- to 60,000-pound-per-hour positive displacement pump	. 03	. 01	. 04
10,000-pound-per-hour centrifugal pump	. 03	0	. 03
366 linear feet-1½ in. I. D. cleaned-in-place pipe, plus fittings	. 47	. 07	. 54
359 linear feet-1½ in. I. D. take-down pipe, plus fittings	. 44	. 07	. 51

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